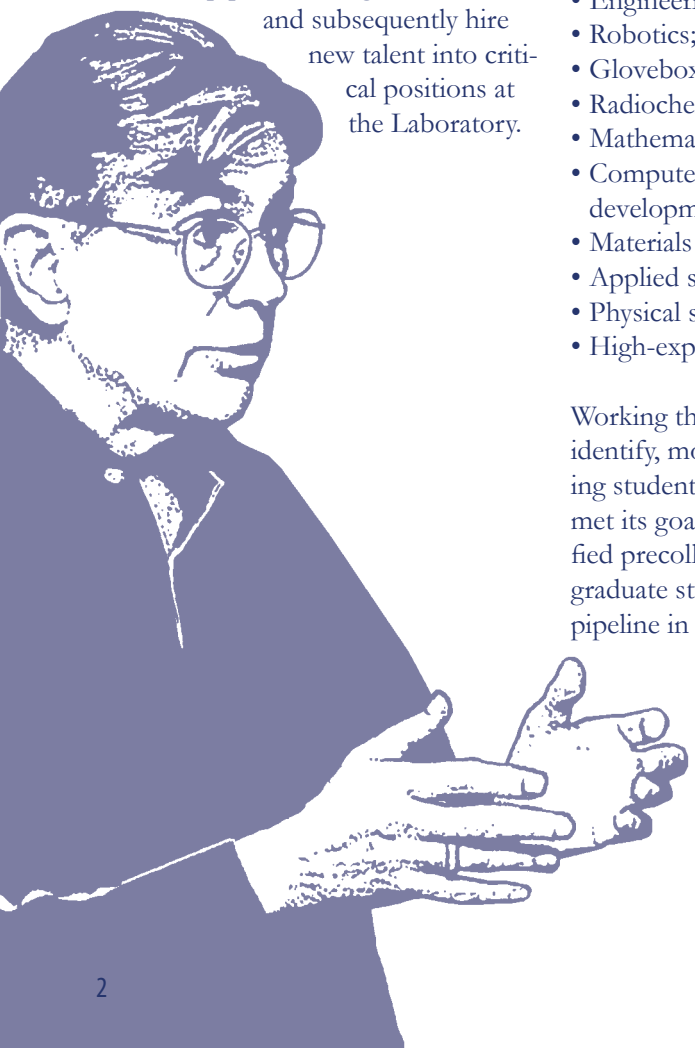
# Section 1
# Critical Skills Development

## Laboratory Critical Skills: Training the Next Generation

Since its inception in the early 1940s, Los Alamos National Laboratory (the Laboratory) has worked hard to maintain the national security of the United States. As the present generation of scientists, engineers, and technicians nears retirement, the Laboratory stands to lose a great deal of corporate knowledge and expertise that in many cases is unique or at the very least esoteric. Without these critical skills, the Laboratory no longer could successfully carry out its national security mission.

Fortunately, the exuberance and infectious enthusiasm of these personnel make them ideal mentors for the current generation of students. Recognizing this, the National Nuclear Security Administration (NNSA) of the Department of Energy has worked with the Laboratory to establish a "student pipeline" designed to attract and subsequently hire new talent into critical positions at the Laboratory.



The Critical Skills Development Program supports Laboratory-initiated projects that address critical-skill needs at the Laboratory. Although customized to meet specific needs, these projects have in common a number of characteristics. Each project has the following qualities:

- It is driven by specific critical skill needs identified by Laboratory line management;
- It is designed by Laboratory management with well-defined objectives and measurable evaluation criteria;
- It is funded jointly; and
- It is structured so that students spend an extended period of time working at the Laboratory.

In fiscal year 2003 (FY03), the critical-skills initiative included 12 programs covering the following disciplines:

- Supercomputing;
- Physics;
- Engineering;
- Robotics;
- Glovebox techniques;
- Radiochemistry;
- Mathematics;
- Computer-system administrator development;
- Materials science;
- Applied science;
- Physical science; and
- High-explosives engineering.

Working through these programs to identify, motivate, and train outstanding students, the critical-skills initiative met its goal of recruiting highly qualified precollege, undergraduate, and graduate students for the Laboratory pipeline in FY03.

## Accelerated Strategic Computing Initiative Internship Program

***Program Description***. To meet strategic workforce development goals, Los Alamos National Laboratory (LANL, the Laboratory) has developed employment pipeline programs that focus on entry-level and strategic hiring—with a simultaneous emphasis on diversity in all forms. One such new program is the Accelerated Strategic Computing Initiative (ASCI) Internship Program. The Laboratory is one of three National Nuclear Security Administration (NNSA) facilities participating in this program.

The ASCI Internship Program is designed to meet knowledge-transfer needs in high-performance computing by encouraging graduate students and upper-division undergraduate students to choose careers related to simulation and the challenging science and engineering problems that directly support national security. Program participants work with and are mentored by Laboratory scientists who are leaders in the development of software applications for massively parallel computers such as the next generation ASCI flagship platform, the Q Machine.

This year-round program recruits highly qualified and diverse United States (U.S.) citizens into the Laboratory's ASCI employment pipeline. Recruiting strategies build on existing relationships with campuses, especially the five ASCI Strategic Alliance Centers of Excellence.

All students in good academic standing who meet the program's qualifying criteria and have recommendations from faculty members and principal investigators are eligible to apply for the program. Once applications are received, key ASCI employees contact the applicants to determine their interests and skills and to establish student

matches to projects. Once a student and a researcher agree upon a mutual project, the student is offered a position, and paperwork is submitted for a security clearance.

Each student is assigned a primary mentor who is responsible for the content and review of the student's work and is expected to submit progress reports to the ASCI Internship Program project director. Students are allowed to work on multiple work phases so that there is flexibility to accommodate the needs of the student, the university, and the Laboratory.

The ASCI Internship Program provides skills that are not usually taught in universities or are in such demand that the Laboratory cannot easily compete for graduates. One example of a difficult recruiting topic is "visualization," for which it is very hard to get qualified applicants for Laboratory job openings. The fact that an increasing percentage of students specializing in visualization are non-U.S. citizens compounds the problem of recruiting qualified U.S. citizens.

To obtain staff members with the critical skills the Laboratory needs, it is necessary to identify prospective candidates early. To do this effectively, the Laboratory must see to it that students develop relationships with staff members at an early stage in the students' education. In the initial year of the ASCI Internship Program—fiscal year 2003 (FY03)—the Laboratory attracted several such students, including one who was just finishing his undergraduate work and another who planned to begin graduate work at the University of California-Santa Barbara in the fall of FY04.

The Laboratory is proud to be a part of the ASCI program and to contribute to the stability and security of U.S. national defense.

***Performance.*** The goals of the ASCI Internship Program are to foster computer science and computational science research efforts at the Laboratory while supporting the Department of Energy (DOE) ASCI program; to supply the Laboratory with much needed computer science talent to feed the employment pipeline; and to ensure continuation of a strong focus on high-performance computing in the academic computer science community.

***Highlights of This Year's Accomplishments.*** Eighteen students—from two ASCI Strategic Alliance Centers of Excellence and 14 other universities—participated in the FY03 ASCI Internship Program. Such successful recruitment is an outstanding accomplishment for a first-year program. (Please see the table in this section, which tells more about the students.)

In addition, participating students produced a number of honors and accomplishments of their own. Following are several examples:

- One ASCI Internship Program student won first place in the computer science undergraduate category at the FY03 Laboratory Student Symposium.
- Another ASCI student helped organize the Materials Modeling and Simulations for Nuclear Fuels Conference, June 9-10, 2003, in Santa Fe, New Mexico.
- A third ASCI intern's contributions will be included in an upcoming presentation at the Society for Industrial and Applied Mathematics (SIAM) Conference on Parallel Processing for Scientific Computing next February.


**Tamer Zaki, an FY03 ASCI intern, is a doctoral candidate at Stanford University working on a thesis involving fluid mechanics. Stanford is one of the five schools in the ASCI Alliance and is visited each year by an alliance advisory committee. One of the visiting advisors told Zaki about the ASCI Internship program in Los Alamos. Zaki said the internship turned out to be a good experience. He was originally scheduled to leave in September 2003, but he extended his time at the Laboratory to December 2003. He noted that in his thesis research, he had been using the Laboratory's QSC Machine long distance from Stanford, but during his ASCI internship, he had the giant computer—and the system administrator—right next door.**

- A fourth ASCI student co-authored a publication entitled "Rotating Concentric Circular Peakons," which was submitted to "Nonlinearity." In addition to his scientific accomplishments, the student also attended an international scientific conference (the SIAM Snowbird Dynamical Systems Conference in Snowbird, Utah, May 25-30, 2003) and an international summer school ("Mathematics in the Geosciences") at the National Center for Atmospheric Research in Boulder, Colorado, July 20-23, 2003.

- A fifth ASCI student's model results will be featured in a textbook soon to be updated by author Dale Ostlie.

***Comments from Mentors***. Following are a few of the comments made by mentors who worked with the students in the FY03 ASCI Internship Program:

*"Andrew proved to be a smart and hard-working student, eager to learn and improve his skills."*

*"Brian turned out be a rather skilled C programmer. Thanks to his diligence, he managed to provide an absolutely stable implementation of the requested software. The newly implemented functions reproduce all the earlier results. In summary, I am very pleased with Brian's performance. I hope that I can attract him to work with me at LANL next summer also."*

*"Although Trevor had little experience in writing software initially, I was impressed by his ability to obtain the necessary computational skills—fast. This (ability) allowed him to complete his work in his rather short stay. I hope that I can attract Trevor to work with me at LANL again next summer."*

*"I was impressed by David's computation skills and the diligence with which he pursued completion of his work. I hope that I can attract David to work with me at LANL next summer also."*

*"This student began development of a comprehensive testing environment in Perl that will facilitate automated regular testing of the code repository and provide a convenient mechanism for comprehensive scalability and performance studies."*

*"In summary, Sam flourished during his summer in Los Alamos. His performance was excellent in every way. We would be delighted if he returned to work with us again in the future. He was also an active participant in weekly meetings of our Turbulence Working Group."*

**Student University and Specialty Information, FY03 ASCI Internship Program**

| Student's University | Topic |
|---|---|
| University of Colorado | Parallel multilevel solver algorithms and code optimization |
| University of Texas | Dynamical systems |
| University of California (UC)-San Diego | Image compression and representation |
| Princeton University | Turbulence, flash hydrodynamics code |
| UC-Davis | Radiation damage |
| New Mexico State University (NMSU) | Multidimension of surface reconstruction and feature extraction |
| UC-Davis | Molecular dynamics |
| Pacific University | Messaging progress |
| University of New Mexico (UNM) | Profiling and architecture-specific tuning of parallel algorithms, such as linear solvers |
| University of Utah | Polymer modeling |
| University of Arizona | Fiber optics |
| New York University | Turbulence |
| NMSU | Multidimension of surface reconstruction and feature extraction |
| Brigham Young University | Calculating the phase diagram and modeling the properties of the plutonium nitrogen systems |
| University of Texas-Dallas | Climate modeling |
| UNM | Solar modeling |
| University of Washington | Foams |
| Stanford University | Numerical simulations of turbulence |

## Adventures in Supercomputing Challenge

***Program Description.*** The New Mexico Adventures in Supercomputing Challenge (AiS, the Challenge) is an educational program that seeks to improve students' understanding and use of technology by developing their skills in scientific inquiry, modeling, computing, communications, and teamwork. Now in it's 13th year, the Challenge is an academic-year-long program in which teams of one to five middle school or high school students conduct computational science projects using high-performance computers. However, during the summer, it is also a computational science and technology-training program for teachers.

Los Alamos National Laboratory (LANL, the Laboratory) has been a major sponsor of the Challenge since 1990, when the Laboratory helped begin the program.The Laboratory saw the need to interest students in science-related disciplines and used the program as a way to help improve the education of students in northern New Mexico. It also saw the Challenge as a way to give back to the surrounding communities and create a very positive Laboratory outreach program.

The program is both an educational experience and a competition that strives to increase students' knowledge of and interest in science-related disciplines; to expose students and teachers to computational experiences; to promote careers in science and engineering; to provide access to high-performance computers; and to institute electronic networking among schools.

The Challenge recruits teams of students to complete science projects using high-performance supercomputers. Each team of one to five students and a sponsoring teacher defines and works on a single computational project of its own choosing,

All teams present their projects at the Awards Expo at the Laboratory in April. Judges evaluate the projects, displays, and presentations. There are presentations of savings bonds and scholarships to individuals, and awards of computer equipment to schools. All of the participants go home as winners because of the Challenge experience.

After presenting their projects, teams take tours of the Laboratory to see the latest high-performance computers, listen to talks by scientists on current research, and participate in demonstrations of Laboratory science and how it serves society.

Although the program is aimed primarily at high school students, in the past few years, middle-school and junior-high students have been allowed to participate. As a result, the program has increased the number of students in the pipeline, and when they graduate from high school they are well advanced in their scientific inquiry skills.

The Challenge has had a positive impact on students, teachers, schools, and communities throughout New Mexico. The Laboratory's participation has had a positive effect on participants' perceptions of LANL. In addition, the Laboratory has been able to use the Challenge to promote good-neighbor practices and has received considerable positive press coverage because of the Challenge.

(Current details about the AiS Challenge can be found at ***http://www.challenge.nm.org)***

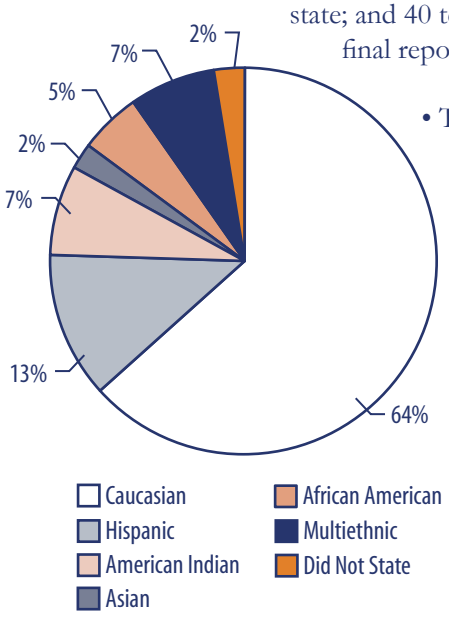
**Students participating in the Supercomputing Challenge are a study in concentration as they work and learn in a Los Alamos computer laboratory.**

***Performance.*** The primary goal of the Challenge is to build the Laboratory's pipeline of computational science talent by making contact with students at the middle-school and high-school levels and improving their understanding of computational techniques. The program met this goal in fiscal year 2003 (FY03) by exposing more than 330 students and teachers to computational experiences, promoting careers in science and engineering, providing access to high-performance computers, instituting electronic networking among schools, and connecting students and technical staff members at the Laboratory.

Other goals of the Challenge are to foster creativity in devising computational solutions to scientific problems and to make a positive difference in students' lives, motivating them to prepare for the workforce of the future.

The program tries to reach out to underrepresented groups by making school visits to rural areas, by encouraging participation in the Summer Teacher Institute (STI), and by promoting gender equity and diversity in discussions with teachers. This year, three new schools participated.

**Ethnicity of Challenge Teachers**




Since the Challenge participants are middle-school, junior-high, and high-school age, it takes a few years before they are ready for full-time employment at the Laboratory. There are currently 67 Laboratory employees who are past Challenge participants.

***Highlights of This Year's Accomplishments.*** Among the program's achievements in FY03 were the following successes:

- The 13th annual Kickoff Conference at Glorieta drew more than 260 students and 40 teachers. Twelve Laboratory employees were among the 26 people who taught classes and discussed team projects with the students. The keynote speaker was Dale Alverson, medical director of the telemedicine program at the University of New Mexico Health Sciences Center. The conference curriculum included the year overview, math modeling, and programming.

- Challenge statistics for the year were impressive: 71 team abstracts were submitted; 58 team interim reports were filed; 54 teams presented their projects to a set of judges at the February project evaluations on Saturdays at seven institutions around the state; and 40 teams submitted written final reports.

- Twelve judges selected seven teams as finalists, and another four teams were selected as finalists at the Awards Expo. The AiS first- and second-place teams and nine honorable-mention teams were selected from among those 11 teams. Awards were presented the next day.

- United States Sen. Pete Domenici, R-N.M., spoke at the awards ceremony and helped present the first- and second-place awards.

- Another speaker, Deputy Laboratory Director William Press, spoke of the Laboratory's need for talent and encouraged the students to consider working at the Laboratory in the future.

- Scholarships worth $27,000 were presented at the year-end awards ceremony.

- In addition, the Laboratory found new sponsors to help with the expenses associated with the competition and the awards ceremony. Public Service Company of New Mexico (PNM) was the largest of these new sponsors. PNM joins a long list of primary sponsors that includes DOE, the Laboratory, the National Aeronautics and Space Administration (NASA) Ames Research Center, and New Mexico Technet.

- The Challenge took over hosting of its own web page (from New Mexico Technet), creating a new online registration procedure that will allow better access to the participant database.

- Eighteen of the 42 participants in the new Cyber Defenders Institute (CDI, a Laboratory internship program funded by Department of Energy (DOE)/Defense Programs) were former Challenge participants.

***Summer Teacher Institute.*** STI, a two-week institute for teachers, is sponsored by the Laboratory and New Mexico Technet in conjunction with San Juan Community College and NASA Ames. The institute encourages participants to return to their schools and champion the Challenge.

The main goal of STI is the development of skills to support computational science for middle-school and high-school students. Topics covered at the institute in FY03 included problem solving, science, math modeling, technology, programming, research, working with mentors, project management, time management, team management, presentations, gender equity, computer ethics, and technical writing.

Participants were provided with room and board and a stipend. They earned three units of graduate credit from New Mexico Institute of Mining and Technology.

Challenge sponsor Hewlett Packard provided IPAQ hand-held computers for each participant. During the institute, the participants learned about operation of the devices and loaded several software packages onto them for use in their projects.

Two textbooks were provided to everyone: a Dreamweaver web-design text and a Java programming text. Additional handouts and Dreamweaver software were also provided.

The participants were grouped into seven teams. Each team developed a project and worked on it for the entire two weeks of the institute. Team members had to do research, programming, technical writing, and presentations. They experienced—in a condensed format—just what teams go through during the Challenge year. They learned the importance of teamwork to a successful project, discovering that team members have different strengths and that all of those strengths are needed.

A guest speaker from NASA's Goddard Earth Sciences and Technology Center conducted an additional workshop with the teachers.

The teachers came from the following schools: Bloomfield High School, Bridge Academy Charter School, Chaparral Middle School, Clovis High School, Desert Academy, Farmington High School, Koogler Middle School, Las Vegas City Schools, Melrose High School, Mesa Alta Junior High School, Rio Rancho Mid-High School, Rio Vista Middle School, SFPS Career Academy, Shiprock High School, and To'Hajiilee Community Schools.

NASA Ames provided the funding for the institute in 2001 and 2002, but funding from NASA Ames did not come though in FY03. The Laboratory and New Mexico Technet scraped together enough funds to hold the event. It is hoped that NASA-Ames will be able to fund the FY04 institute.

The participants expressed positive feelings about being treated as professionals. Following are a few quotations from participant evaluations of the institute:

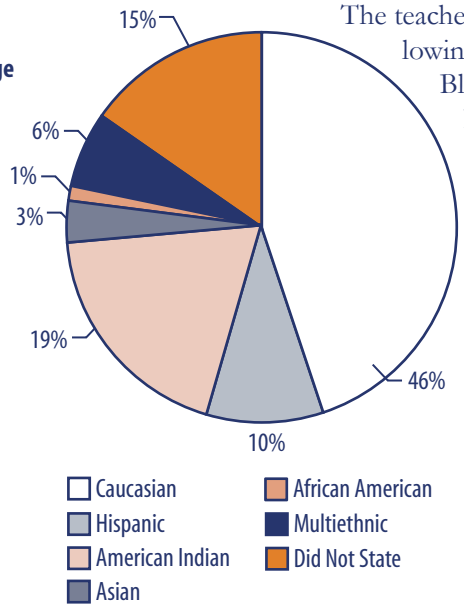
*"This has been a 'GREAT' experience. Wow. Everything flowed very well, and I learned so much."*

*"The instructors are excellent."*

*"This is a well prepared and thought out institute. It fires you up, and you're ready to go get a team."*

*"Thanks so much for an indescribable learning experience."*

**Ethnicity of Challenge Students**



## Applied Science Internship Program

*"I like it here. I've enjoyed it. The Lab is really nice. I like the science that goes on."*
*Christopher Carey, a student in engineering physics from Ohio State University*

***Program Description.*** Fiscal year 2003 (FY03) marked the second year of existence for the Applied Science Internship Program (ASIP) at Los Alamos National Laboratory (LANL, the Laboratory).

ASIP is a joint venture involving the Physics Division and the Materials Science and Technology Division at the Laboratory, and several academic institutions including New Mexico Institute of Mining and Technology in Socorro, Massachusetts Institute of Technology (MIT), and Northern New Mexico Community College (NNMCC) in Española.

ASIP is an undergraduate experimental training program based in the Plasma Physics Group (P-24) and the Subatomic Physics Group (P-25) of the Physics Division. The program seeks to develop student skills in the physics and engineering of lasers, pulsed power, accelerators, inertial confinement fusion, high-energy density physics, and weapons aspects of two fields—dynamic experimentation and diagnostics, and underground experimentation.

ASIP adds an essential component to the Laboratory's student employment pipeline by providing two avenues for recruitment to supply the Laboratory's future workforce. First, the program provides continued support for students throughout their academic careers, increasing the likelihood that they will choose to work at the Laboratory. Second, ASIP networks with universities, focusing on near-term hires and on undergraduate- and graduate-level students.

The large, continuing, year-round student population of ASIP has created a culture that is luring more high-quality students to the Laboratory. ASIP is now bombarded with excellent resumes elicited by word-of-mouth recommendations from alumni. Program leaders are finding jobs elsewhere in the Laboratory for many students they cannot hire themselves because of funding and space limitations. In P-24, 60% of the students return, stay for long-term internships, or do both.

ASIP has, in fact, reached the point at which expansion will be required to admit more new students.

The Physics Division is committed to hiring new staff members from the program. It is assigning staff members to develop the curriculum; providing staff support for development of associate-degree, bachelor's-degree, master's-degree, and doctoral curricula; and recruiting students to fill the program.

***Performance.*** This project seeks to recruit students and train them rapidly to become contributors to the Laboratory's Stockpile Stewardship Program; to develop and hire highly qualified students into the Laboratory critical-skills pipeline; and to provide a reliable source of exciting jobs and feedback on curriculum development for area educational institutions so that they can attract higher quality students.

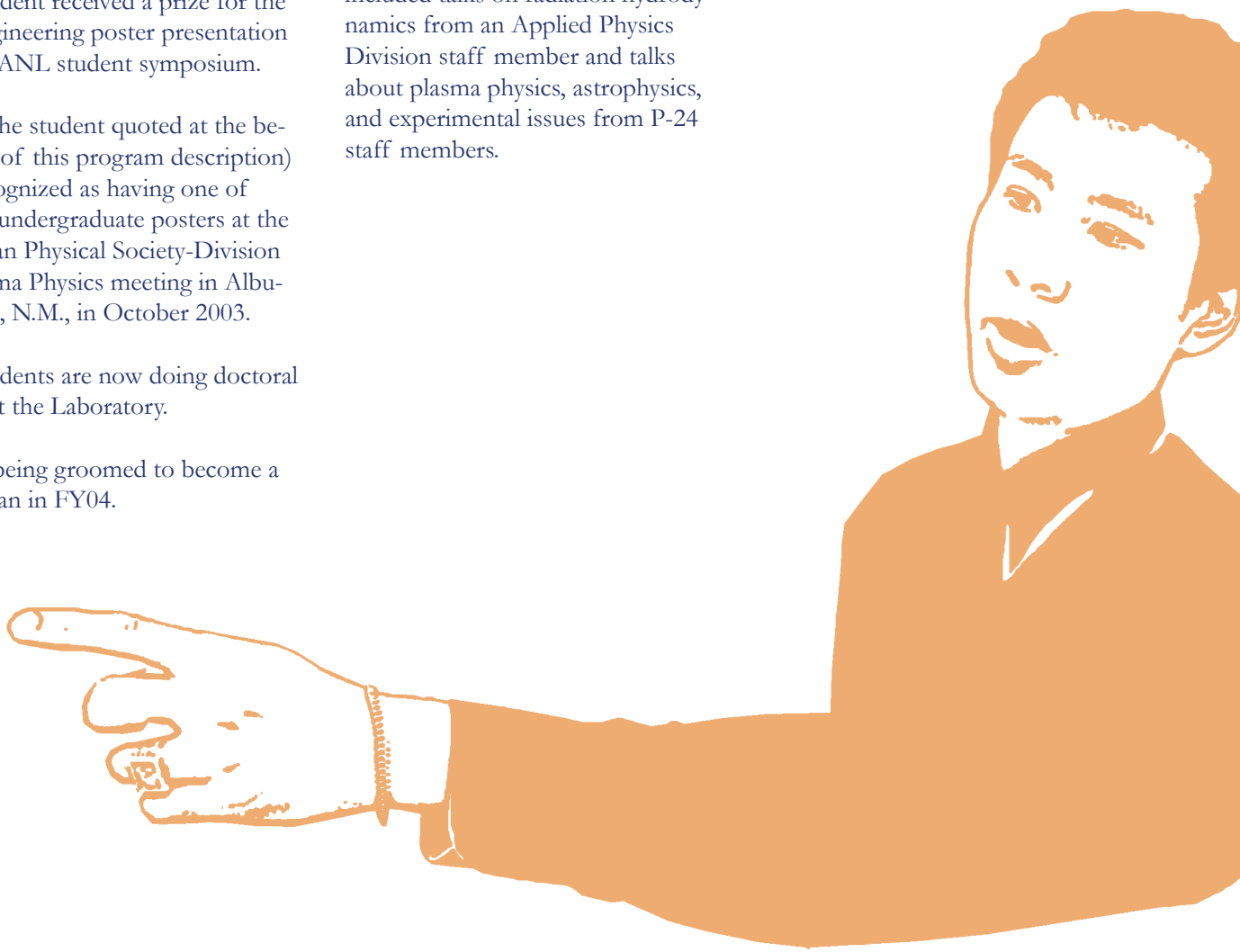
Recruitment for ASIP focuses on networking with collaborating universities and professors, providing continuing support of individual students throughout their academic careers, and identifying near-term hires from the pool of high-quality undergraduate and graduate students. The ASIP website has established a presence in the outside world, reinforcing program recruiting efforts and successes.

The program encourages long-term student work-study semesters lasting a minimum of four to six months. This approach benefits the students, who get a continuous research experience with concrete and publishable results. It also allows the long learning and training curve (two months or more) necessary for sophisticated work in a national-laboratory environment. Students are sent to conferences and symposiums where they present their work, network with their peers, and attract more students to the Laboratory.

All established program milestones were met in FY03.

***Highlights of This Year's Accomplishments.*** ASIP had many successes in FY03. The following list describes a few of them.

- In FY03, the ASIP program included 26 students. It retained a record number. Eleven out of 13 returned from the previous year's program in P-24 alone.
- The schools represented by students in ASIP included MIT, Stanford University, Princeton University, NNMCC, Purdue University, the University of Michigan, Clarkson University, and the University of Pennsylvania.
- In FY03, eight ASIP students had fellowships from outside the Laboratory.
- One student received a prize for the best engineering poster presentation at the LANL student symposium.
- Carey (the student quoted at the beginning of this program description) was recognized as having one of the top undergraduate posters at the American Physical Society-Division of Plasma Physics meeting in Albuquerque, N.M., in October 2003.
- Two students are now doing doctoral theses at the Laboratory.
- One is being groomed to become a technician in FY04.
- One is the lead author on an accepted paper, and another co-authored a paper that has already been published.
- Three are going to graduate school—two to the University of Wisconsin and one to the University of Nevada-Reno.
- Two stayed at the Laboratory beyond the summer. A large number of the FY03 students are expected to return in FY04.
- ASIP's Plasma Physics Summer School Seminar Series often attracted more than 30 students per class. The series was coordinated with two other student programs at the Laboratory—the Summer School in the Physical Sciences, and the Dynamics Summer School. The seminar series included talks on radiation hydrodynamics from an Applied Physics Division staff member and talks about plasma physics, astrophysics, and experimental issues from P-24 staff members.
- ASIP organized a Laboratory-wide workshop on plasma astrophysics that drew more than 70 people.
- And ASIP received an MIT Undergraduate Practice Opportunities Program (UPOP) Internship Excellence Award that carried with it a $2,000 stipend for each MIT UPOP student who interned at P-24.



**Student Information, ASIP FY03**

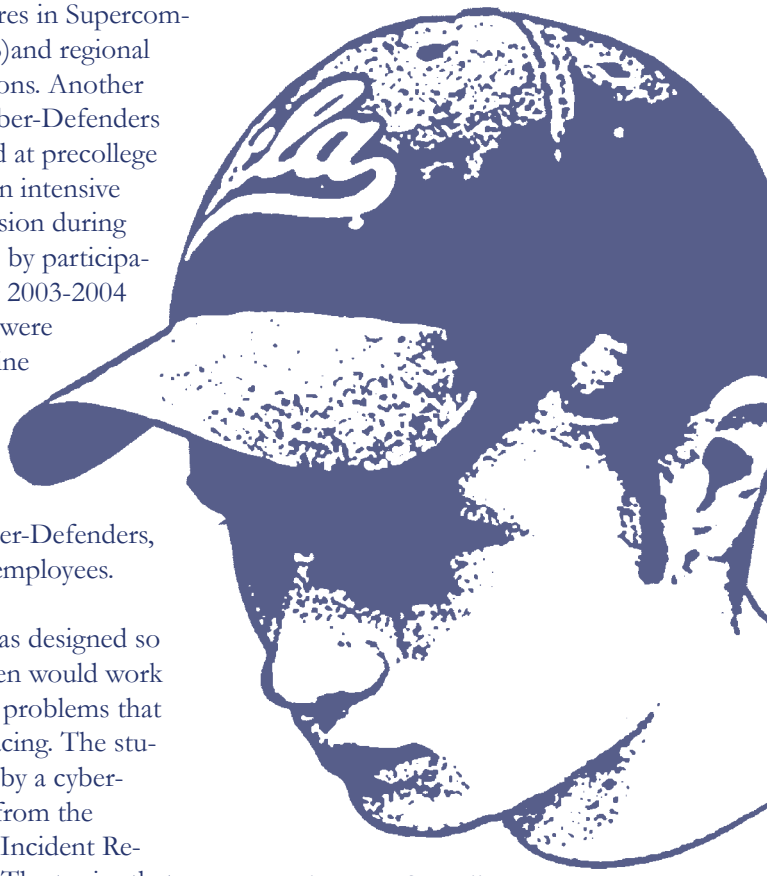
| College/University | Area of Research at LANL | Gender/Ethnicity |
|---|---|---|
| Carnegie Mellon University | Plasma diagnostics, field reversed configurations | Male/Caucasian |
| Clarkson University | Three-dimensional plasma probe positioner | Male/Caucasian |
| Dartmouth College | Laboratory astrophysics, magnetic reconnection | Male/Caucasian |
| Duke University | Industrial plasmas | Female/Caucasian |
| Massachusetts Institute of Technology (MIT) | Plasma diagnostics, field reversed configurations | Male/Caucasian |
| MIT | Plasma diagnostics, field reversed configurations | Male/Hispanic |
| MIT | Laboratory astrophysics, magnetic reconnection | Male/Asian |
| MIT | Dynamic materials | Male/Caucasian |
| Mercer University | Optical diagnostics, tokamaks | Female/Caucasian |
| Ohio State University | Tomographic inversion of tokamak data | Male/Caucasian |
| Princeton University | Laboratory astrophysics, magnetic reconnection | Female/Caucasian |
| Purdue University | Power balance, field reversed configurations | Male/Caucasian |
| Stanford University | Laboratory astrophysics, magnetic reconnection | Male/Caucasian |
| Texas Tech University | Machine design, diagnostics | Male/Caucasian |
| The College of New Jersey | Machine design, diagnostics, helicon antenna | Male/Caucasian |
| Cooper Union for the Advancement of Science and Art | Plasma diagnostics, magnetic reconnection | Male/Caucasian |
| The University of California-Irvine | Plasma diagnostics, field reversed configurations | Male/Caucasian |
| The University of Colorado-Boulder | Industrial plasmas | Male/Caucasian |
| The University of Michigan (UM) | Optical diagnostics, data analysis | Male/Caucasian |
| UM | Industrial plasmas | Female/Caucasian |
| The University of Nevada-Reno | Electro optics | Male/Caucasian |
| The University of New Mexico-Los Alamos (UNM-LA) | Electronics, field reversed configurations | Male/Hispanic |
| The University of Oklahoma | Machine design, diagnostics | Male/Caucasian |
| The University of Pennsylvania | Optical diagnostics, Thomson scattering | Female/Caucasian |
| The University of Texas-Dallas | Optical diagnostics | Male/Caucasian |
| UNM | Programmable logic controllers | Male/Caucasian |
| UNM | Laboratory astrophysics, magnetic reconnection | Male/Caucasian |

## College Cyber Defenders Program

***Program Description.*** United States (U.S.) computer systems are increasingly vulnerable to cyber attacks, partly because security measures already in place are not being properly implemented, but mostly because of the lack of adequate investment in training, new technologies, and improved procedures. In November 2002, Congress approved $903 million in grants to spur federal agencies, industry, and universities to devote more energy to cyber-security research. "For too long, cyber-security has just not been a research priority," said Rep. Sherwood Boehlert, R-N.Y., chairman of the House Science Committee and sponsor of the legislation. "In an age of terrorism, such willful ignorance about cyber-security has got to come to an end."

Since cyber-security involves much more than computer viruses, and almost everything in the Department of Energy/Defense Programs (DOE/DP) complex runs on computer systems, it is essential for Los Alamos National Laboratory (LANL, the Laboratory) to meet the growing need to build a strong workforce knowledgeable in computer security. The Los Alamos College Cyber Defenders (CCD) Program was created to meet this need.

CCD was initiated at the Laboratory in fiscal year 2003 (FY03) to help prepare a highly qualified cyber-security pool from which the Laboratory and DOE could hire cyber-security professionals. The focus was on undergraduate and graduate students. The program also included a component for elementary school students in grades 7 through 12 that was intended to allow early exposure to cyber-security topics that might lead children to work on cyber-security projects during other programs such as the DOE Adventures in Supercomputing Challenge (AiS)and regional science fair competitions. Another compontent—the Cyber-Defenders Institute (CDI), aimed at precollege students—provided an intensive two-week training session during the summer, followed by participation in AiS during the 2003-2004 school year. Students were then placed in a pipeline from which the Laboratory plans to recruit future Cyber-Defender Institute students, College Cyber-Defenders, and new Laboratory employees.



The CCD program was designed so college students chosen would work on real cyber-security problems that the Laboratory was facing. The students were mentored by a cyber-security professional from the Laboratory's Security Incident Response Team (SIRT). The topics that projects covered ranged from vulnerability scanning systems to detection of steganography and analysis of attacks.

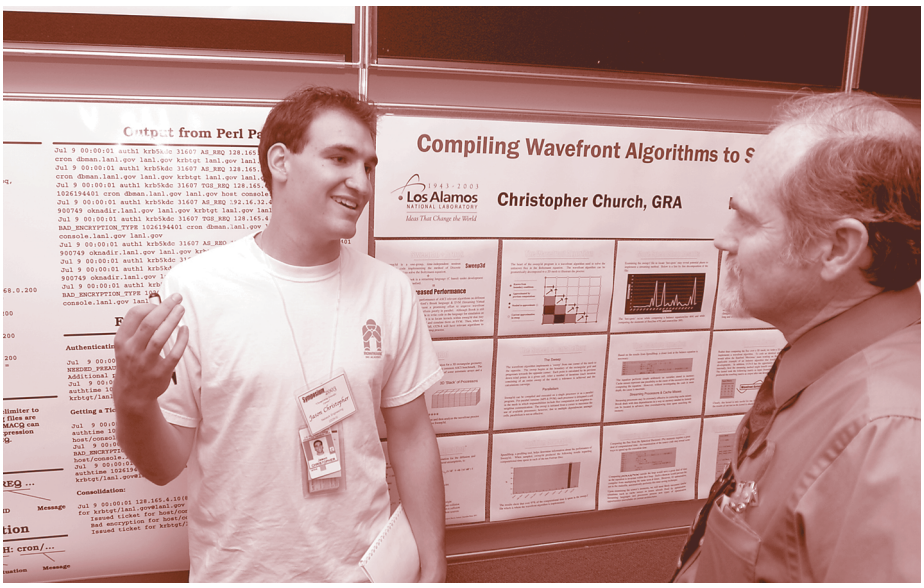
The focus of CDI was to sharpen students' computing skills and to introduce them to common cyber-security concepts and problems. During the two-week institute, the students learned C++ programming and the UNIX operating system, and became knowledgeable about computer hardware and basic computer networking. In addition, each team of four students completed a guided project in one of the following research areas: firewall construction and design, operating-system fingerprinting, distributed denial of service (DDoS) attacks, viruses and worms, network steganography, image steganography, encryption, network intrusion detection, authentication, and computer forensics.

***Performance.*** The goal of the FY03 CCD was to support the Laboratory employment pipeline in cyber-security and information infrastructure protection research and development by recruiting the most talented undergraduate and graduate computer science students, training them, educating them, and providing real-world experiences for them in the areas of cyber-security and information infrastructure protection research. The program sought to create a diverse pool of employees in a critical skill of great importance to the DOE complex and national security. The Laboratory expanded the reach of the program by holding CDI, a two-week program for middle-school and high-school students in which participants were introduced to cyber-security, programming, and the UNIX environment.

To accomplish these goals, program leaders did the following things:

- Recruited 11 college students from top universities (locally and nationally) for the summer 2003 program. Each of the students worked directly on a LANL cyber-security project under the direction of a Laboratory cyber-security professional. Each student completed a project, paper, and presentation at the end of the summer to demonstrate work completed. Students took part in five research seminars during the summer in which they read, presented, and discussed recent publications in the field of cyber-security.

- Retained two students as co-ops during the 2002-2003 school year—one at the University of Southern California (USC) doing research in DDoS attacks and the spread of worms and viruses, and one at New Mexico Institute of Mining and Technology (New Mexico Tech) doing forensic analysis.




**Student Jason Christopher explains his poster presentation to an interested visitor during Symposium 2003. Christopher was an FY03 participant in the College Cyber Defenders Program.**

- Hired one of the CCD graduate students as a full-time technical staff member at the Laboratory because of his excellent work during the FY03 CCD program.

- Supported two faculty collaborations—withUSC for research on DDoS attacks, and with New Mexico Tech for research in computer forensics.

- Planned and implemented the CDI for 44 middle-school and high-school students and prepared a curriculum that introduced these students to C++ programming, the UNIX environment, and cyber-security.

***Highlights of This Year's Accomplishments.*** The major achievements of FY03 fall into four categories.

**College Cyber-Defenders Program.** Students in the FY03 CCD program were recruited from top colleges around the nation in spring 2003 and converged on the Laboratory in early June 2003. These students were professionally mentored and monitored throughout their research experience. They began the program by meeting with their mentors and learning about the cyber-security issues they would be addressing. Throughout the program, they were exposed to an ideal learning environment that challenged the advanced students with cutting-edge research projects and taught various levels of new skills to all students. These skills included management of computer networks, analysis and understanding of various operating systems, and understanding of computer forensics techniques. As students progressed through the program, they specialized in one field and completed a project, presentation, and a paper on their work for the 2003 LANL Student Symposium.

The highlights from the summer included the following:

- The program recruited four graduate students and seven undergraduate students for the first annual CCD summer program.
- The program hosted five summer research seminars during which students presented current, relevant cyber-security publications to their peers and led discussion groups on those topics.
- One freshman-level undergraduate CCD student started the summer undecided about her major in college but finished the summer by declaring a major in computer science at her university.
- Each student worked directly with a Laboratory cyber-security professional on a cyber-security problem that the Laboratory was facing.
- Four CCD students helped mentor the students at the institute.
- Approximately 90% of the FY03 CCD students plan to return to the Laboratory next year in the field of cyber-security as either CCD students or LANL staff members.

Following are a few comments from FY03 CCD students:

*"My internship experience this summer was one of personal and professional growth, and I am honored I was chosen as a participant. I hope to return to LANL next summer."*

*"This last summer was an educationally enriching experience with good hands-on work and direct one-on-one mentoring, with not just a good exchange of ideas between mentors and students but also among the Cyber-Defender students themselves."*

*"I really enjoyed experiencing the frontiers of cyber-security research while working with security professionals at LANL."*

**Cyber-Defenders Institute.**
The Cyber-Defenders Institute was held in Farmington, New Mexico, at San Juan College, in conjunction with the AiS Summer Teacher Institute. The two programs shared some of the costs involved to minimize expenses. The students were provided with shared hotel accommodations, per diem, laptop computers for their personal use during the institute, all textbooks and supplies, and a small stipend.

Highlights from the institute included the following:

- Forty-four middle-school and high-school students registered and participated.
- The Laboratory successfully encouraged the participation of females and minorities. Overall, 31% of the institute participants were from minority groups, and 30% of the participants were female.
- Students attended classes on the basics of C++ programming and the UNIX operating system, basic computer networking, and computer hardware.
- Students worked on cyber-security projects with teammates and presented their work to their parents, fellow students, and LANL staff members on the last day of classes.
- More than 90% of the students chose to continue their studies in computers and have registered for the 2003 AiS.
- Two of the students who will be graduating in May 2004 have been selected as students for next summer's College Cyber-Defender program.

Following are a few comments from students and parents:

*"I have only been in the CDI for three days, and I have already learned more about computers than I learned in the last year at school."*

*"This is a very beneficial opportunity for the students of New Mexico, and I am honored that I had the chance to participate."*

*"The CDI was a raging success on many levels.... Because of (my son's) CDI experience, his AiS project will go much smoother and won't be nearly as intimidating."*

*"I wanted to thank you for giving (my son) a wonderful opportunity with computers. He came home with such enthusiasm! This was a wonderful opportunity for him."*

**Funding.** To make the CCD and CDI possible with the funding available, program leaders worked with several other organizations to find additional money and equipment. This approach made it possible for the program to reach 55 students on a budget of only $2,727.27 per student. Following is a list of donations:

- The Laboratory donated office space for the use of the 11 CCD students during the summer at a savings to the CCD program of $800/day (approximately $48,000).
- San Juan College donated classroom space and wireless Internet access for the CCD students during the two-week institute.
- The New Mexico Technet Computer ReRuns Program donated the use of 45 laptop computers (approximately $90,000 worth of equipment) for the CCD students to use during the institute.
- The Laboratory donated 10 new laptops and four slightly-used laptops for the CCD students to use during the summer at a savings to the CCD of approximately $30,000.
- The Laboratory paid all of the costs for student travel to and from their universities at a savings to the CCD program of $15,000.
- The Laboratory donated $5,000 worth of textbooks for the CDI students.
- The Laboratory paid the salaries of four of the CCD students, and the CCD paid the salaries of the remaining seven students, which allowed the program to offer positions to 37% more CCD students than originally planned.
- The Laboratory provided mentors for each student and a cyber-security professional to run both programs full-time at no cost to the program.

**Public Relations.** The CCD and CDI programs both had a direct and positive impact on New Mexico students and college students from around the nation. As a result of these programs, many students were introduced to the field of cyber-security and computing, and the Laboratory was able to hire qualified, experienced, and knowledgeable cyber-security students who are well-versed in a critical skill of great importance to the DOE complex and national security. These programs placed the Laboratory in a positive light. Program leaders are already receiving unsolicited applications for next summer's CCD and CDI and hope to expand these programs in FY04.

## Computer System Administrator Development Initiative

***Program Description.*** Computing is a critical resource at Los Alamos National Laboratory (LANL, the Laboratory). The Laboratory has more than 21,000 desktop workstations and servers providing electronic workplace services to every member of the Laboratory workforce. About 70% of the workstations are used in the weapons program. Drivers such as operating-system complexity, the convergence of more technology onto the desktop computer, and ever-increasing computer security demands require that the Laboratory have a ready supply of competent and capable computer system administrators.

The Computer System Administrator Development Initiative (CSADI) is designed to recruit students who are enrolled in area colleges and universities and want to develop their skills as computer system administrators in UNIX, NT, and network administration. The project is intended to ensure that the Laboratory will continue to have a pipeline filled with students who are developing the talent to meet LANL Department of Energy/Defense Programs programmatic deliverables in high-performance computing and simulation.

The CSADI recruiting strategy is to develop partnerships with the chairs of the computer science departments at partner institutions, work with them to advertise the internship opportunity during the spring semester, and include them in the subsequent interview and selection processes. The schools that have been targeted are Northern New Mexico Community College (NNMCC), Santa Fe Community College (SFCC), the University of New Mexico (UNM), the College of Santa Fe, and the University of New Mexico-Los Alamos (UNM-LA).

Students are eligible for a CSADI internship after they have completed the first year of a college degree program in computer science or computer/network administration. Potential interns must be high school graduates; they must have completed at least 30 hours toward a degree (finishing their first year so that they know something about computers and so that faculty members know about their performance); they must have at least a 3.0 grade point average (GPA); and they must have a recommendation from a faculty member.

CSADI has been a very successful program because it identifies, recruits, and develops the best and brightest students early in their educational careers in computer and network administration. In addition, CSADI increases retention rates by working with local colleges to find individuals who want careers in New Mexico and at the Laboratory.

***Performance.*** The goal of this project is to develop and hire highly qualified computer system administrators to support Laboratory computing and the Laboratory mission of Nuclear Stockpile Stewardship.

CSADI had the following milestones in FY 2003 (FY03):

- Develop and mentor at least five new students in addition to the five added in fiscal year FY02;
- Develop at least three of the FY02 students to the point of hiring into LANL permanent positions; and
- Develop contacts with New Mexico Highlands University (NMHU) and New Mexico State University (NMSU) to begin expanding the program.

All milestones were met.

***Highlights of This Year's Accomplishments.*** CSADI began reviewing applications and scheduling interviews in April 2003 with active participation from the chairs and faculty of each participant school. As a result, four students were selected to participate in the program (two from NNMCC, one from UNM-LA, and one from the College of Santa Fe). These four new students joined five students continuing in the program from previous years. The new students included two Hispanic males, one black female, and one white male. The mentors for each of the students will guide their development and contributions at the Laboratory. The students completed their first five-month rotation in the group during the spring and summer of FY03 and, in October, reached the point of a job-assignment rotation intended to give them a broad view of the Laboratory and an opportunity to work with different customers and computer environments.

CSADI contacted the computer science departments at NMHU and NMSU and planned to visit each campus in the fall of 2003 to discuss the internship program and the possibility of adding them as partners.

The Desktop Computing (CCN-2) staff continues to be delighted with the quality of the students in CSADI. The interns are very eager to learn and to work with the Laboratory. They also bring to LANL some exciting and fresh new ideas about computing. The feedback from students indicates that they really appreciate the opportunity to experiment and to apply their academic knowledge in real computing environments at the Laboratory. They also view the Laboratory as a very positive work and learning establishment.

For more information about the students in the program, please consult the table shown below.

**Ethnic and Gender Analysis of the CSADI Program**

| Program Fiscal Year Participant School | Participant School | Participating Students | Continuing Students | Conversions to Full-Time Technician Positions (2 Contractor, 7 University of California) |
|---|---|---|---|---|
| 2001* | NNMCC | 1 Female/Hispanic | | 1 Female/Hispanic |
| | SFCC | 1 Male/White<br>1 Female/Hispanic | | 1 Male/White<br>1 Female/Hispanic |
| | UNM-LA | 1 Male/Hispanic<br>1 Male/White<br>1 Female/Hispanic | 1 Female/Hispanic | 1 Male/Hispanic<br>1 Male/White |
| | New Mexico Institute of Mining and Technology | 1 Male/Hispanic | | 1 Male/Hispanic |
| 2002 | NNMCC | 2 Males/Hispanic | 1 Male/Hispanic | 1 Male/Hispanic |
| | SFCC | 2 Males/White<br>1 Female/Hispanic | 1 Female/Hispanic | 2 Males/White |
| 2003 | UNM-LA<br>NNMCC<br>UNM<br>College of Santa Fe | 2 Males/White<br>2 Males/Hispanic<br>1 Male/White<br>1 Female/Black | 2 Males/White<br>2 Males/Hispanic<br>1 Male/White<br>1 Female/Black | |
| TOTALS | | 18 | 9 | 9 |

***Before being funded as "CSADI," the program was funded under the Critical Skills Development Program as the Developing Information Systems Careers (DISC) program.**

## Dynamics Summer School

***Program Description.*** It was a startling statistic: The Engineering Workforce Commission of the American Association of Engineering Societies revealed in its document "Engineering & Technology Degrees, 1999" that over 20 years, there had been a 20% decline in the number of engineering degrees granted—while university degrees in general had increased approximately 20%.

Engineering dynamics—which encompasses areas such as flight dynamics, vibration isolation for precision manufacturing, earthquake engineering, blast loading, signal processing, and experimental modal analysis—is naturally affected by this decrease. The competition for talented individuals with the potential to replace people leaving the field of engineering dynamics necessitates a proactive approach to identifying, motivating, and educating students who are embarking on their graduate school careers.

The Los Alamos Dynamics Summer School (DSS) was designed with this proactive approach in mind. The program is designed not only to benefit the students through their educational experience, but also to motivate them to attend graduate school, and to make them aware of career possibilities in the Department of Energy (DOE) laboratories that will open up after they have completed their graduate studies.

The summer school has two focus areas. First, the multidisciplinary nature of research in engineering dynamics is emphasized. To this end, the students are organized into multidisciplinary teams and assigned projects in which a coupled analytical/experimental approach to dynamics problems is required. Second, the program seeks to develop the students' written and oral communications skills. To develop these skills, the student groups are required to give numerous informal oral presentations of their work as it progresses. This process culminates in a formal presentation and a paper written for a technical conference.

A new aspect of the summer school in fiscal year 2003 (FY03) was that every student had to do a presentation and an intermediate writing assignment that was critiqued by mentors.

Fifteen students participated in the fourth DSS in the summer of 2003. Eleven planned to be university seniors in the fall of 2003, and four planned to start graduate school. Most of the students (10) were mechanical engineering majors. One was a civil engineering major; two were electrical engineering majors; and two were aerospace engineering majors. The mean grade point average (GPA) for the students was 3.74 on a scale of 4.0. The students came from Stanford University, the University of California-Los Angeles, the University of Denver, Embry-Riddle Aeronautical University, Colorado State University (CSU), Virginia Polytechnic Institute and State University (Virginia Tech), Georgia Institute of Technology (Georgia Tech), the University of Houston, Montana State University (MSU), and Michigan Technological University. Those going on to graduate school in the fall planned to attend the University of Illinois, the University of Massachusetts-Lowell, the University of California-Berkeley, and the University of Colorado.

The centerpiece of the summer school was an eight-week project that had analytical and experimental components. The experimental component was a critical aspect of the program because practical experimental activities in engineering dynamics are almost nonexistent at the undergraduate level. Students were placed in teams of three and assigned a project. An attempt was made to make the groups as multidisciplinary and diverse as possible. Students from the same school were not assigned to the same team. Each team had a mentor from Los Alamos National Laboratory (the Laboratory). The mentors worked closely with their groups, providing guidance, encouragement, and technical expertise. All of the projects resulted in papers to be presented at the 2004 International Modal Analysis Conference (IMAC). The titles of the resulting papers are listed below:

- Failure Prediction in Composite Plates with Impact-induced Damage
- Optimal Power Harvesting Using PZT Materials
- Structural Damage Detection Using Chaotic Time Series Excitation
- Modifying Self-Sensing Circuit to Increase Stability of Vibration Control
- Shaker Control in the Presence of Nonlinearities

Each student was provided with appropriate equipment including a high-end personal computer with numerical-analysis and signal-processing software. Each research group had access to a multichannel data-acquisition system, and finite-element-analysis software was made available to each research group as necessary.

The students took several field trips during the summer. Among the places they visited were the Aging Aircraft Facility, Robotics Facility, and Micro-Electromechanical Systems Facility at Sandia National Laboratories (Sandia).

Each week a prominent guest lecturer in the field of engineering dynamics gave a talk about cutting-edge research in structural dynamics. Most of the lecturers spent two to three days in Los Alamos. They spent time with the students, discussing their projects and providing suggestions and motivation. One new feature this year was a presentation on applying to graduate school and applying for graduate fellowships.

The students received instruction on a variety of topics in engineering dynamics. There were tutorials on general topics such as random vibrations and computational structural dynamics, and, in addition, there were demonstration/application lectures on more specific topics. All student groups were required to perform a correlation study comparing analytical and experimental modal analysis of a structure. This assignment assured that the students had the chance to apply the material that was presented in tutorials.

**Los Alamos Dynamics Summer School students and staff members pose for a group photo at Hot Rocks Java Café in the Los Alamos Research Park during their end-of-program picnic.**

***Performance.*** The performance objectives and milestones originally defined for the program can be summarized in the following statements:

- The eight-week program is designed for a select group of 15 upper-division, undergraduate or first-year graduate students who are citizens of the United States.
- Attempts are made to identify high-quality students from diverse (human and academic) backgrounds.
- Every attempt is made to identify students from universities that emphasize undergraduate education as well as research institutes.
- The program seeks variety in academic disciplines including the fields of aerospace engineering, civil engineering, mechanical engineering, electrical engineering, computer science, and mathematics/statistics.
- The program exposes students to the multidisciplinary aspects of structural dynamics through analytical/experimental research projects.
- It develops students' written and oral communications skills.
- It makes students aware of career possibilities at DOE/Defense Programs (DP) laboratories.
- Students are required to provide written feedback regarding their experiences during the summer school.
- Laboratory and DOE education program offices are provided with an annual summary of the summer school and its demographics.
- The program maintains an alumni database to track the careers of the summer school participants, quantifying the success of the summer school in meeting its intended goals of motivating the students to attend graduate school and pursue engineering careers at DOE/DP laboratories. This database is available at the DSS website: www.lanl.gov/projects/dss.

All of these objectives and milestones were met in FY03. Even though the funding provided was significantly less than requested, the summer school was kept at the same number of days and the same number of students (15). The Laboratory's Engineering Science and Applications Division (ESA) stepped in and filled the financial gap associated with DOE funding cutbacks and the expansion of the summer school.

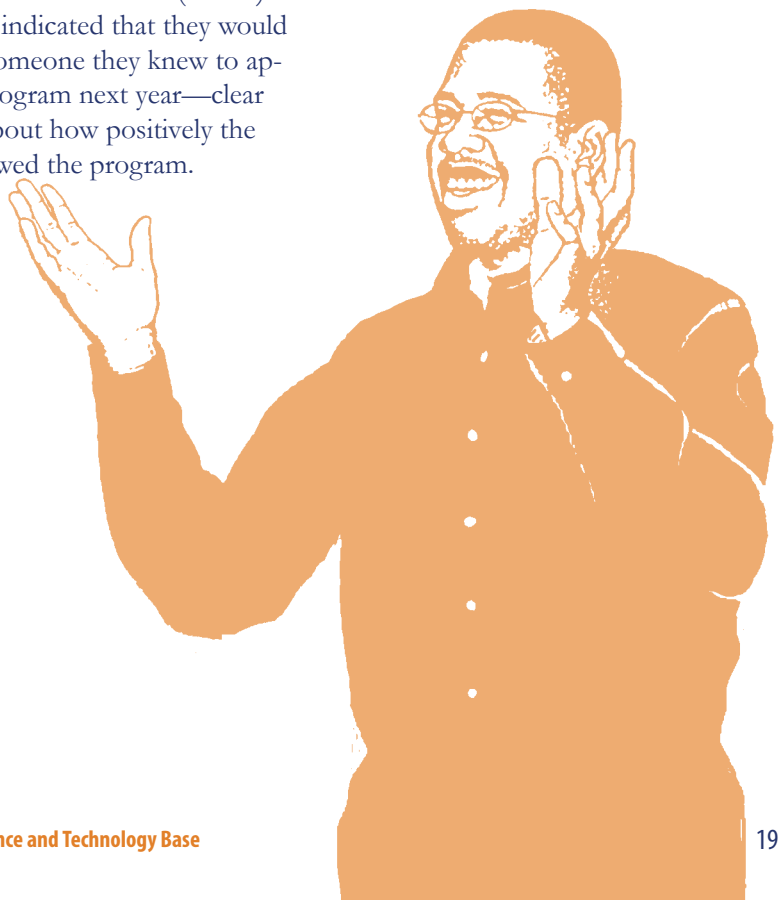
Students were required to provide feedback about their experiences in the summer school program. A web page was set up, and all such evaluations were done on-line and automatically compiled. This feedback included evaluations of speakers, field trips, and the guest lecturers, plus a final evaluation of the summer school. The assessments of speakers and guest lecturers will be used to decide which speakers to invite back next year. Overall, the lecturers were rated highly.

Seventy-five percent of the students indicated a desire to return to the Laboratory in subsequent summers as graduate research assistants (GRAs). All students indicated that they would encourage someone they knew to apply to the program next year—clear testimony about how positively the students viewed the program.

The guest lecturers provided oral feedback on the student projects and the students themselves. This feedback was overwhelmingly positive.

Leading software companies provided very significant support. The MathWorks, Inc., Vibrant Technology, Inc., and Hibbitt Karlsson & Sorenson, Inc., provided software that would have cost more than $1 million if purchased. These software donations were crucial to the success of this summer school. ESA provided 20 new personal computers (desktops for student and laptops for data-acquisition systems) at a cost of more than $100,000. The Weapon Response Group in ESA provided the administrative support essential to the success of the summer school.

The organizers of the IMAC Conference have set up a special session for DSS students to present their papers in 2004. ESA will provide financial support so that all of the summer school students can attend the IMAC Conference.



***Highlights of This Year's Accomplishments.*** The program appears to have achieved its primary goals of introducing a talented group of engineering students to both analytical and experimental engineering structural dynamics and making the students aware of career opportunities at national facilities such as Los Alamos, Sandia, and Lawrence Livermore National Laboratory. Seven students from the three previous summer schools returned to Los Alamos this past summer as GRAs, and an eighth worked as a GRA at Sandia.

The Laboratory hired two more summer-school alumni as full-time technical staff members.

One of these new hires had graduated with a master's degree in engineering mechanics at Virginia Tech. This woman had a 3.94 undergraduate GPA in civil engineering at MSU and is one of three summer-school graduates who have gone on to win National Science Foundation graduate fellowships.

The second person hired was a Hispanic man who graduated with a master's degree in mechanical engineering from Texas A&M University.

Sandia hired a 2000 DSS alumnus who earned his master's degree in mechanical engineering from Georgia Tech.

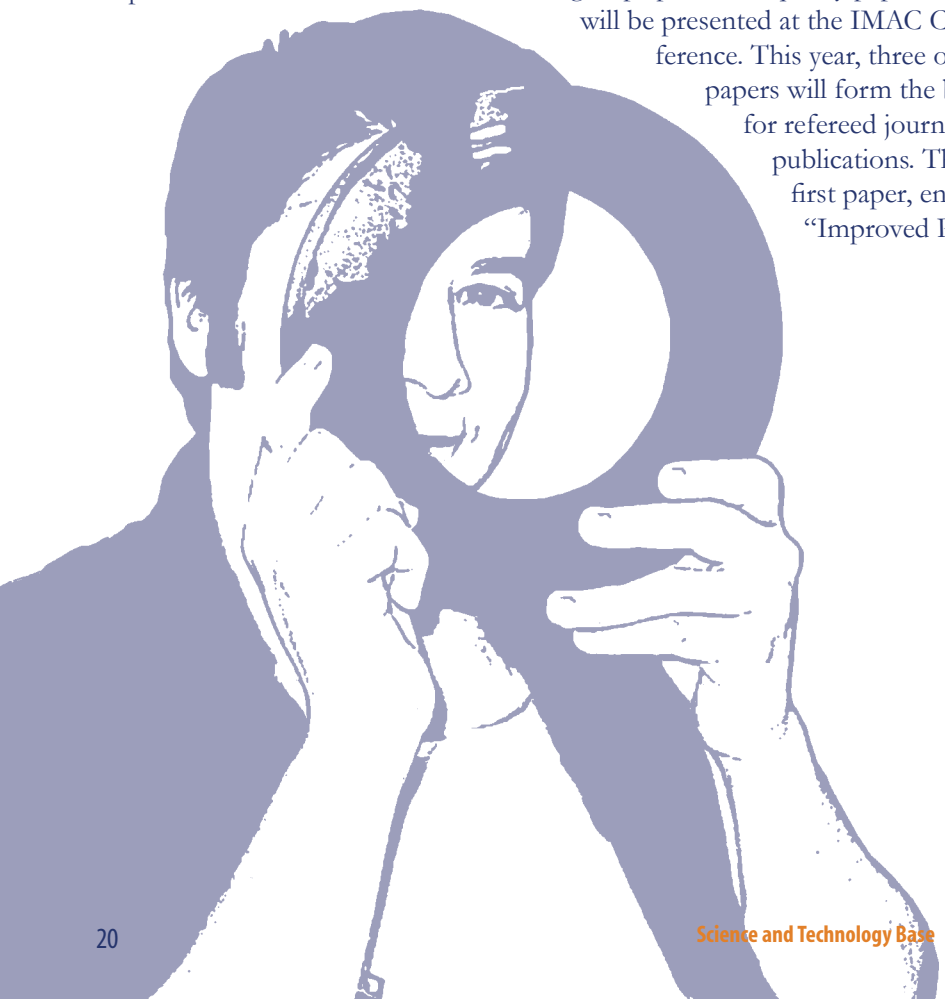
Clearly, the five technical staff members hired from this program—including two women and one Hispanic man—show that the recruiting aspect of the summer school is paying dividends. This accomplishment directly addresses an issue raised in the Chiles Commission Report (Recommendation No. 7) to "establish and implement plans on a priority basis for replenishing essential technical workforce needs in critical skills."

The students rated the summer school as excellent, and every student indicated that he/she would encourage someone he/she knew to apply to the summer school. All the student groups produced quality papers that will be presented at the IMAC Conference. This year, three of the papers will form the basis for refereed journal publications. The first paper, entitled "Improved Piezoelectric Self-Sensing Actuation," has just been submitted to the Journal of Intelligent Material Systems and Structures.

The oral presentations that the students made to the staff in ESA were among the most important highlights of the summer. Division managers noted—as they had for the past three summer schools—that the student presentations were of the same quality as Laboratory staff high-level program reviews. (The students' conference papers, along with their viewgraphs, are available on the DSS website.)

In the summer of 2004, the program plans to add a nondestructive evaluation (NDE) component to DSS. In addition, the number of students in the program will be increased from 15 to 18. One three-person research team will focus on ultrasonic inspection, and another will focus on computer tomography. These additions to the program are motivated by ESA's difficulties in recruiting people in NDE. NDE expertise is essential to meet the Laboratory's Stockpile Stewardship responsibilities.

Finally, it should be noted that the DSS program's reputation has grown to the point that the number of applications in 2003 increased by a factor of almost three from 2002. This increase is attributed primarily to the efforts of former students who encourage their friends and colleagues to apply. As a result, this year the program had to turn away students with GPAs in excess of 3.8.



**Companies Donating Software to DSS**

| Company | Software | Purpose |
|---|---|---|
| The MathWorks, Inc. | MATLAB® (plus all toolboxes and Simulink) | Numerical analysis and signal processing |
| Hibbitt, Karlsson & Sorenson, Inc. | ABAQUS® | Finite element analysis |
| Vibrant Technology, Inc. | ME'scopeVES | Vibration data analysis |
| Dynamic Design Solutions | FEMtools™ | Correlation of numerical and experimental results |

**Distinguished Lecturers**

| Name | Title, Organization | Title of Talk |
|---|---|---|
| Michael Alley | Instructor, Department of Mechanical Engineering, Virginia Tech | "Technical Writing Workshop and Presentation Preview" |
| Randy Allemang | Professor of Mechanical Engineering and Director of the Structural Dynamics Research Laboratory, University of Cincinnati | "Modal Analysis Case Histories" |
| Fred Costanza | Head, Underwater Shock Analysis Branch, Naval Surface Weapons Center, Carderock, Maryland | "Underwater Shock Testing and Analysis" |
| Yakov Ben-Haim | Professor of Mechanical Engineering, The Israel Institute of Technology | "Information-Gap Reliability of Dynamic Systems" |
| Dan Inman | Director of the Center for Intelligent Material Systems and Structures; George R. Goodson Professor of Mechanical Engineering, Virginia TechMonitoring and Control" | "Smart Structures, Structural Health |
| Nick Lieven | Department Head, Aerospace Engineering Department, University of Bristol, United Kingdom | "Structural Dynamics Issues for Aerospace Structures" |
| Chuck Farrar | Structural Diagnostics Team leader, Los Alamos National Laboratory | "Structural Health Monitoring" |
| Mike Todd | Associate Professor, Structural Engineering Department, University of California-San Diego. | " High-Performance Fiber Optic Sensing" |

**Additional Instruction Received by the DSS Students**

| Title | Presenter | Title, Organization | Number of Lectures |
|---|---|---|---|
| Confinement Vessel Blast Analysis | Jason Pepin | Staff Member, Los Alamos National Laboratory (LANL) | 1 |
| Satellite Testing and Analysis | Tom Butler | Staff Member, LANL | 2 |
| A Rigid Body Dynamics Code–ADAMS | Ryan Maupin | Staff Member, LANL | 1 |
| High Explosives Radio Telemetry System | Tom Peterson | Staff Member, LANL | 1 |

**Titles and Presenters of Multilecture Tutorials**

| Title | Presenter | Title, Organization | Number of Lectures |
|---|---|---|---|
| Rigid Body Dynamics | Phillip Cornwell | Professor of Mechanical Engineering, Rose-Hulman Institute of Technology | 3 |
| Sensors and Data Acquisition | Hoon Sohn | Staff Member, Los Alamos National Laboratory (LANL) | 3 |
| Structural Dynamics | Pete Avitabile | Assistant Professor of Mechanical Engineering; Founder and President of Dynamic Decision, University of Massachusetts-Lowell | 3 |
| Signal Processing | Pete Avitabile | Assistant Professor of Mechanical Engineering; Founder and President of Dynamic Decision, University of Massachusetts-Lowell | 2 |
| Experimental Modal Analysis | Pete Avitabile | Assistant Professor of Mechanical Engineering; Founder and President of Dynamic Decision, University of Massachusetts-Lowell | 3 |
| Advanced Signal Processing | Amy Robertson | Hytech Incorporated | 2 |
| Computational Structural Dynamics | Jobie Gerkin | Staff Member, LANL | 4 |
| Model Validation | Francois Hemez | Staff Member, LANL | 2 |
| Controls Systems with Applications to Structural Dynamics | Matt Bement | Staff Member, LANL | 2 |
| Nonlinear Vibrations | Doug Adams | Assistant Professor, Purdue University | 5 |
| Environmental Testing | Norm Hunter | Staff Member, LANL | 2 |

**Summary of Mentors**

| Mentor, Affiliation | Area of Expertise |
|---|---|
| Mike Todd, University of California-San Diego | Nonlinear Dynamics |
| Chuck Farrar, LANL ESA-WR | Structural Health Monitoring |
| Gyuhae Park, LANL ESA-WR | Smart Material and Structures |
| Hoon Sohn, LANL ESA-WR | Machine Learning |
| Peter Avitabile, University of Massachusetts-Lowell | Experimental Modal Analysis |
| Phil Cornwell, Rose-Hulman Institute of Technology | Rigid-Body Dynamics |
| Matt Bement, LANL ESA-WR | Control Systems |

## Glovebox Technician Pipeline Program

***Program Description.*** The Glovebox Technician Pipeline Program (GTPP) fills a critical need that is now and will continue to be a serious problem for both Los Alamos National Laboratory (the Laboratory) and the Department of Energy (DOE).

Skilled radiological glovebox technicians are increasingly difficult to hire, and the current method of training and educating new hires is inefficient and inconsistent. Realizing the importance of keeping this critical area of the nuclear workforce viable, the Nuclear Materials Technology (NMT) Division developed the Glovebox Technician Pipeline Program to target potential technicians in the readily available local workforce. Projected needs of the division within the next four years call for hiring as many as a few dozen new technicians for nuclear-materials oriented jobs.

NMT Division also recognizes the need for a quality education, especially for new hires. The current demand for technicians outstrips the availability of candidates with associate degrees. This problem is exacerbated by the fact that there is no direct connection linking broadcasting the demand for technicians, directing their education, and supplementing their skills so that they can be readily employed by NMT. Even though NMT has a reasonable student population during the summer months in accordance with Laboratory initiatives, no existing programs address the problems the division faces in hiring skilled entry-level technicians.

The demand for technicians in future years will still be substantial, and GTPP will be the single most significant source of entry-level technicians for the division. Fiscal year 2003 (FY03) was the pilot year for the project. NMT is committed to developing this project completely in FY04. By orienting students early in their college years to glovebox techniques, NMT can create early interest and commitment and produce potential technicians who already have critical skills. The preparation of such a workforce from the local population is in the best interests of the division, the Laboratory, DOE, and northern New Mexico.

***Performance***. The major goal of this program is to provide technicians who have a college-level education coupled with basic skills in glovebox technology and radiological safety. Such technicians are ideally suited for hiring directly into entry and midlevel positions within NMT Division. One basic objective is going to the local schools and recruiting potential technicians for the initiative. Another is building or utilizing existing facilities for demonstration and practice in glovebox skills and nuclear-material handling. These skills would be enhanced by the provision of an educational background in fields such as chemistry, materials science, mechanics, and electronics.

NMT would like to guide these full-time students through their entire educational process with the intention of hiring them once they obtain a certificate toward a degree (after two years in the program). NMT intends to bring the most promising candidates on board early as undergraduate student (UGS) employees in NMT, where they can learn more critical skills on-site, most likely at Technical Area 55.

Once this program matures, it should produce a small pool of program graduates available for full-time employment. By the summer of 2006, the program should be adding approximately six graduates per year to the pool.

***Highlights of This Year's Accomplishments.*** Since the FY03 funding was not received until April, recruitment could not be completed for the fall semester of 2003. As a result, the program had to be re-evaluated and then presented again to the NMT Division management. The NMT leaders still support the establishment of the program, but at a more conservative level.

Several critical decisions were made in FY03. NMT employees who presented the plan to a group of Northern New Mexico Community College (NNMCC) staff members learned that they would not be able to have the glovebox lent to them by the Laboratory ready in time for an FY04 start. As a result, NMT decided that the only practical move was to employ existing facilities in Technical Area 55 for the glovebox training courses. Once that decision was reached, it made sense in terms of cost and timely response to choose the University of New Mexico-Los Alamos (UNM-LA) instead of NNMCC as the training center. NMT thus decided that UNM-LA would be the contractual administrator for the program. Program leaders are formulating a contract with UNM-LA. NMT hopes that funds can be retained and/or obtained for FY04 in a time frame that will coincide with program milestones.

In many ways, this is still a new program. Students will not be coming into the program until the fall of 2004.

**Gary Braun, a chemistry major at the University of California-Santa Barbara, was an intern at the Laboratory in FY03. His personal goals involved graduate work in inorganic or physical chemistry, but—as shown here—his research as an intern often required sound glovebox techniques. The Laboratory employs many scientists who must have such skills for their research—but it also has a significant and continuing need for technicians who have training in radiological glovebox techniques and nuclear materials handling. The Glovebox Technician Pipeline Program is aimed at producing an employment pool of people with such training.**

## Go Figure Mathematical Challenge and Internship Program

*'Students who continue to work on the math problems long after the Go Figure test is over may have what it takes to tackle many of the real-life problems in our world.'*
*Abe Hillman, founder of the Go Figure Mathematical Challenge*

***Program Description.*** The Go Figure Mathematical Challenge and Internship Program (Go Figure, the Challenge) is dedicated to strengthening the mathematical capabilities of young people by identifying, recognizing, and rewarding students talented in mathematical thinking. The Challenge is co-sponsored by Los Alamos National Laboratory (LANL, the Laboratory) and Sandia National Laboratories (SNL). It is funded by the United States (U.S.) Department of Energy (DOE)/Defense Programs (DP).

The expectations of the Challenge include: engaging talented students and involving them with the laboratories in summer internships to increase the likelihood of recruiting them as permanent employees; understanding and mastering the development of Go Figure problems and solutions to ensure continuance of the program as an alternative method for identifying talent; and increasing interest in mathematics and developing problem-solving abilities through friendly yet challenging mathematics contests. Students participating in the program are reminded that mathematics and algebra are the building blocks for all of the scientific disciplines and that without these foundations, their career opportunities would be severely limited.

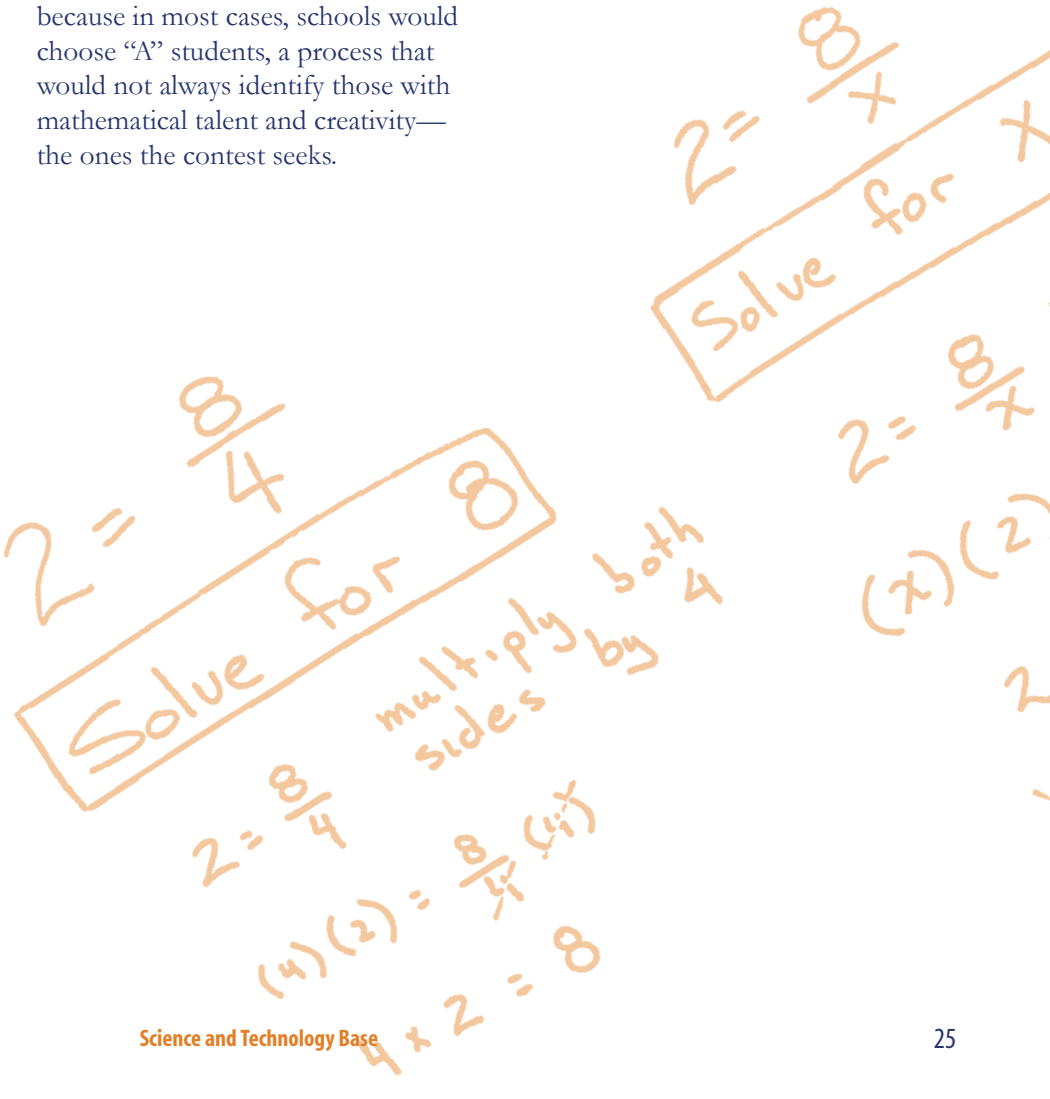
Go Figure targets students from the seventh grade through the 12th grade in northern New Mexico and provides them with an opportunity to participate in problem solving and other enriching mathematical experiences. The program is intended for everyone from the average student who enjoys mathematics to the very best student who excels in mathematics.

Participants are offered 13 problems and given two and a half hours to solve them. Problems selected require a minimal amount of knowledge and a great deal of creativity, originality, and analytical thinking. When the contest is graded, credit is given for supporting work so that originality and creativity are rewarded.

There is no restriction placed on the number of participants. The program avoids putting schools in the position of deciding who will represent them because in most cases, schools would choose "A" students, a process that would not always identify those with mathematical talent and creativity—the ones the contest seeks.

Go Figure recruitment strategies include: site visits to schools by the Laboratory program coordinator and by Laboratory technical staff members; local radio and TV public service announcements on the program; news releases about the program run in local newspapers and the Laboratory Newsbulletin; and general information provided on the Go Figure website.

Implementation of new approaches in FY2003 (FY03) launched the Challenge to a higher level of success. The program developed and implemented a Summer 2003 Internship Program at the Laboratory and recruited Go Figure winners as participants under the guidance of outstanding mentors. The summer internship program included hands-on, minds-on activities, tours of the Laboratory, and opportunities to meet and work with Laboratory mathematicians, computational scientists, and nuclear engineers.



Program improvements in FY03 also included participation in the Critical Skills Database, which tracks students during their college years to help program managers stay in touch with talented students and recruit the most promising ones for internships and positions in the Critical Skills Development Program (CSDP) at the Laboratory. During FY04, the program will continue to recruit student participants from Santa Fe Indian School, Santa Fe High School, and Capital High School in Santa Fe, New Mexico. The program will also seek to involve more math teachers, and it will hold another banquet in Farmington and a new banquet in Santa Fe.

The program's track record in running successful Go Figure contests is valuable. In addition, working with other Go Figure sites allows the Laboratory Go Figure program to share successes and lessons learned and, as a result, provide students with the best possible Go Figure Challenge experiences.

***Performance.*** The Challenge seeks to stimulate interest in math, science, and technology by exposing students to the basics of applied mathematics with the ultimate goal of recruiting these students into on-site student internships that will lead to future careers at the Laboratory.

The main performance objective of the program is to enhance the supply of well qualified mathematicians, especially at the Laboratory, by providing tools and resources to prepare students for induction into the workforce pipeline. The goal is to create a renewed interest in mathematics in northern New Mexico by encouraging student confidence in mathematics and fostering connections between content knowledge of mathematics and its application in the area of national security. Many students first develop an interest in mathematics through problem-solving activities such as Go Figure. Through the development and promotion of such programs, the Laboratory can promote an improvement in the attitudes of teachers, students, and their parents toward the ability to understand and apply mathematics.

Throughout the Go Figure experience, students and teachers are encouraged to develop a web-based communications network. The intent is to create a strong educational support network among the participants and surrounding institutions of higher learning including the Laboratory and San Juan College. Students are encouraged to take practice tests and view previous years' exams on the website to prepare better for the contest.

All milestones were met in FY03.

***Highlights of this Year's Accomplishments***. The highlight of the FY03 Challenge was the new internship component, which provided participants with a "hands-on" educational experience working with Laboratory technical staff members. Two past Go Figure winners served internships at the Laboratory during the summer.

The highly successful Four Corners Go Figure Mathematical Challenge was held on October 19, 2002. There were 114 student participants from the seventh through the 12th grades. The contest was held at San Juan Community College (in Farmington, New Mexico), and at Los Alamos (New Mexico) Middle School, Española (New Mexico) Middle School, and Cuba (New Mexico) Middle School. The Laboratory sponsored all four contest sites. Contest participants accepted the challenge of a two-and-half-hour test on problems that ranged from easy to very difficult. Most enjoyed the contest and found it mentally stimulating and challenging.

A banquet honoring the winners of the contest was held in Farmington on October 29, 2002. It was well attended, drawing students, teachers, and parents. The highlight of the evening was a presentation by Vernon Willie, a professor at San Juan Community College. The banquet also featured a guest speaker and manager from Citibank. Both presenters spoke of the importance of mathematics in students' personal lives. They also emphasized the need for students to develop a good math background so that they can compete in college and do well in science and business applications courses.

As in previous years, Abraham Hillman, Professor Emeritus in Mathematics at the University of New Mexico, was a valuable contributor to the development, implementation, and success of the Go Figure Challenge. It will be important to capture the essence of Hillman's approach to planning, grading, and recruiting as Go Figure grows in popularity.

Program refinements and improvements in FY04 will be based on lessons learned in the summer of FY03 and on student evaluations. One planned improvement is to give the 2004 summer interns a hands-on experience with the new Powerwall Theater, a visualization environment completed in the spring of 2003, which has overhead projection and wrap-around features supporting the latest virtual-reality and visionarium environments. Another planned improvement is to have the students use the facility to do hands-on work and utilize supercomputers to solve a mathematical/computer-simulated problem under the direction of technical staff members.

One valuable addition to the Challenge this year was mathematician Jane Lataille of the Laboratory's Facility and Waste Operations Fire Protection Program Office. Lataille, who has written and published many articles on mathematics, was trained as a proctor for Go Figure contests and was a featured speaker at the Go Figure banquet at San Juan Community College in December 2003. She spoke on "Women in Mathematics."

***Comments from Participants.*** Following are a few of the comments made by interns and mentors in the FY03 Go Figure program.

*"I had a really good experience last summer. I was given a project that had relevance to the Lab, and I felt important while I was doing it."*

*"The Go Figure Contest and Summer Internship program have opened many doors for me, and I plan on taking advantage of every opportunity afforded to me by this great program."*

*"As scientists, we must educate and train our replacements early. We must mentor them and nurture them so that one day they can excel and contribute to the advancement of science. In my career at the Laboratory, I have mentored about 27 students. I enjoy working with them. They bring a lot of energy and a new way of thinking to the projects."*

**Demographics of FY03 Go Figure Interns**

| School Attended | Research Area | Gender/Ethnicity |
|---|---|---|
| Los Alamos, New Mexico, High School | Subatomic Physics | Male/Asian |
| Farmington, New Mexico, High School | Applied Mathematics | Female/Anglo |

## High-Explosives Engineering Training Program

***Program Description.*** The Department of Energy (DOE) Weapons Complex has a demonstrated need to capture and retain the knowledge accumulated by engineers, scientists, and technicians over the past 60 years. Employees who were working when today's weapons were being built are being lost to retirement. New employees need to be brought up to speed on the decisions made, the technology, the parts and assemblies—wisdom and information that are not necessarily common knowledge.

For this transfer of knowledge to occur, new employees need a basic understanding of energetic materials, their processing, and their behavior.

The goal of the High-Explosives Engineering Training Program (HEET) is to locate and recruit to Los Alamos National Laboratory (LANL, the Laboratory) promising engineers who have both a desire to develop expertise in the area of energetic materials and an interest in working within the Weapons Complex.

Such education is currently available through a very limited program at New Mexico Institute of Mining and Technology (New Mexico Tech), the home of the Energetic Materials Research and Testing Center (EMRTC). Currently, the program at New Mexico Tech involves only graduate students who select a specialization in explosives engineering within the master-of-science program in engineering mechanics—and only candidates with an exceptional record in a bachelor's-in-engineering program are accepted into the master's program. New Mexico Tech has promised to expand the program to include a doctorate in energetic materials, and, possibly, other options.

The HEET staff is also working with the University of Missouri-Rolla in an effort to persuade the university to incorporate a bachelor of science in explosives engineering and, perhaps, an associate or certificate option into its mining engineering program. A certificate program could be used to fast-track apprentice machinists, teaching them about explosives, safety, chemistry, handling techniques, and how to write safety procedures—things that might otherwise require years of on-the-job training.

Students in HEET (all United States citizens) are submitted for Q clearances and receive a variety of hands-on experiences at both EMRTC and the Laboratory—experiences that give them the opportunity to be trained on state-of-the-art equipment. Laboratory staff members mentor these interns and are active members of their thesis committees. Laboratory staff members also contribute by providing guest lectures in classes and at seminars, by becoming adjunct professors, and by developing meaningful projects for both independent study and thesis work. These projects put the students at the cutting edge of today's science and technology issues and allow them the opportunity to work at the Laboratory during the summer as well as during the semester.

Currently, students are recruited solely from universities that have an explosives engineering program. Very few of these programs exist; most are associated with mining engineering programs. New Mexico Tech's program is the only known program that relates explosives and material responses—an approach that is pertinent to the DOE mission. The program at New Mexico Tech also includes professors who have previously worked within the DOE complex and are familiar with its systems. The classes taught by these professors are specifically tailored to address the use of explosives in weapons, as opposed to the use of explosives in mining operations. It might become possible to "hybridize" programs, encouraging students from other universities to supplement their existing course plan with specific classes from New Mexico Tech.

Students are selected for HEET on the basis of advisor recommendations, grade point averages, and presentation skills. The advisor's recommendation is the most important factor. In the past, prospective students have been evaluated through observation during their presentations at conferences, or they have been asked to prepare and present an explosives-related topic to Laboratory staff members. To be selected, students must also show a genuine interest in becoming part of the Laboratory, and they must be capable of obtaining a Q-clearance.

***Performance.*** The ultimate goal of HEET is to hire new engineers who have a good working knowledge of both explosives and nuclear weapons systems. Recruitment is part of an effort to reestablish the Laboratory as a leading technical center for the engineering and manufacturing of high explosives (HE). Relevant knowledge must be obtained both through formal education and through "passing of the torch" from those who built the current weapons systems.

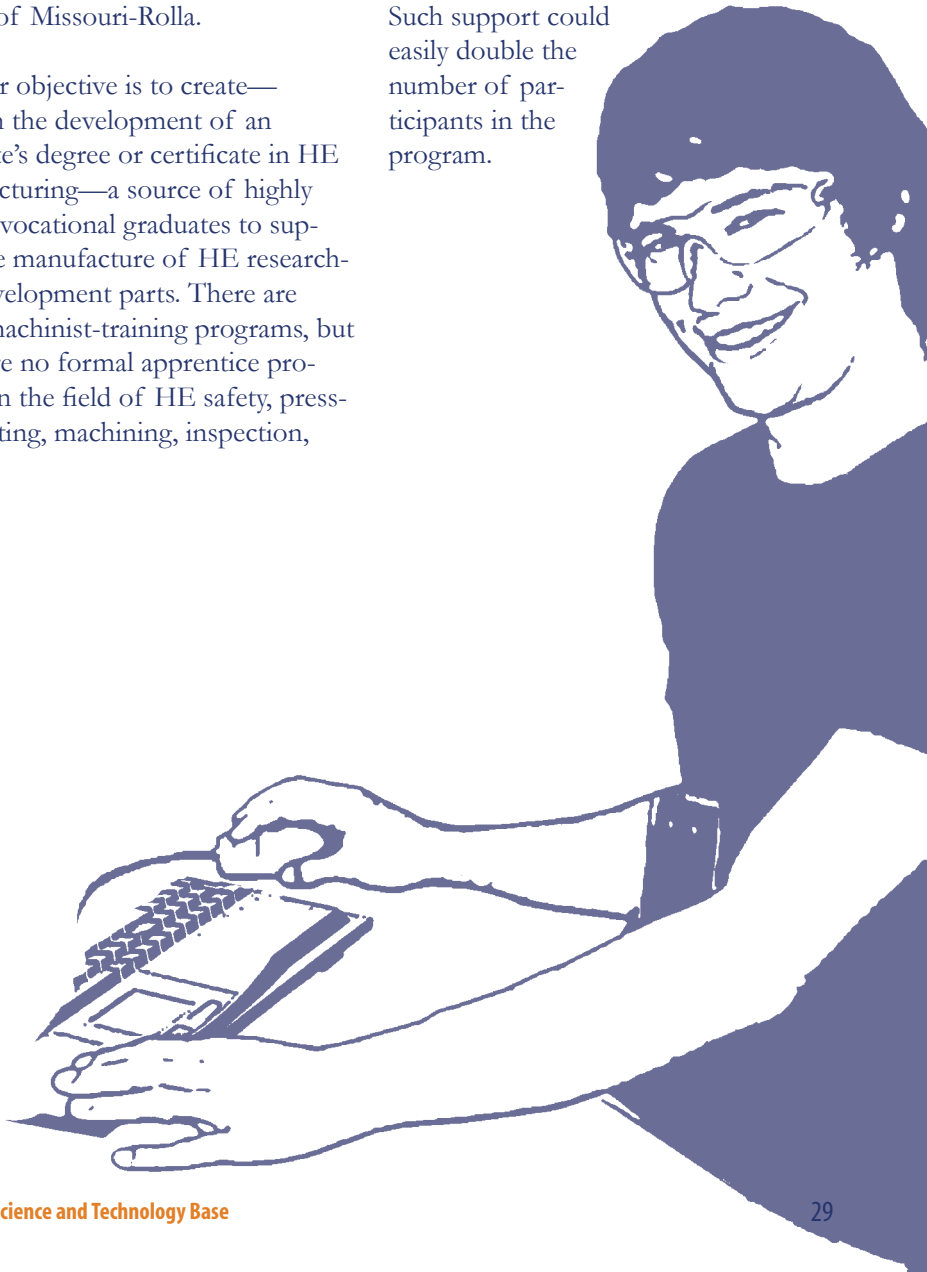
The new engineers selected must have hands-on experience with explosives. They will fill needs in several critical-skills areas at the Laboratory, including shock and detonation physics, dynamic experimentation, manufacturing, and materials science and technology.

HEET provides special expertise in explosives, including knowledge of mechanical and thermal characterization, compatibility issues, weapons material processing, fabrication, testing and evaluation, and weapons safety, performance testing, and analysis. The program also provides expertise in the areas of manufacturing-process development, component fabrication, inspection, and assembly. HEET education focuses specifically on explosives used in the DOE complex and fielded nuclear weapons. It also covers research and development on new formulations of both HE and mock explosives.

One objective of HEET is to recruit beginning graduate students who will later—upon the completion of a degree program—join a team within the Laboratory involved in explosives. Despite intermittent funding, the program has already produced one such staff member at the Laboratory. The reestablishment of funding in fiscal year 2003 (FY03) allowed for the recruitment of four new students. Three of these students are master's degree candidates at New Mexico Tech. The fourth is a Ph.D. candidate at the University of Missouri-Rolla.

Another objective is to create—through the development of an associate's degree or certificate in HE manufacturing—a source of highly trained vocational graduates to support the manufacture of HE research-and-development parts. There are many machinist-training programs, but there are no formal apprentice programs in the field of HE safety, pressing, casting, machining, inspection, and disposal. The Engineering Science and Applications Division's Weapons Materials and Manufacturing Group (ESA-WMM) at the Laboratory plans to take a proactive approach to staffing the research-and-development manufacturing line for the coming years, working with New Mexico Tech and other universities to build graduate, undergraduate, and associate-level internship programs.

ESA and the Dynamic Experimentation Division (DX) at the Laboratory currently support the HEET program. It is hoped that other divisions—such as Physics, Applied Physics, and Earth and Environmental Sciences—may see the benefits of the program and agree to sponsor students also. Such support could easily double the number of participants in the program.



***Highlights of This Year's Accomplishments.*** HEET's most significant accomplishment so far is the hiring in FY03 of a full-time Laboratory staff member who was the first student in the HEET pilot program two years ago. This new employee was hired as an explosives engineer on the Explosives Team within ESA-WMM. He is currently working on a project to execute full-scale explosives testing to benchmark large computer models and improve understanding of operational safety hazards for a reduced high-explosives processing center footprint.

The condensing of operations into one building introduces safety concerns for everyone involved. The most serious concern is what would happen to workers in nearby bays should an HE charge accidentally detonate. The response of the 50-year old concrete building and blow-out doors is not fully understood. One of the current HEET students is learning from this staff member (who is his mentor) and from others working on this critical project. There is considerable room to add additional students to such a project. (For a dramatic illustration of why this is an important project, please look at the photograph, elsewhere in this section, of a 1959 explosion.) Other HEET students are involved in a wide range of activities including the following projects: the burning of explosives scrap of various diameters as a method of waste disposal; the development of an apparatus for safely measuring the thermal-physical properties of explosives; research and development on new techniques for tool force detection; and the creation of conceptual designs for mitigating blast effects caused by an HE detonation.


**In 1959, an explosion occurred in Bay 2 of Building 260 in the High-Explosives Processing Center. This photo shows the results.**

Funds received in FY03 were used to co-sponsor a conference on non-ideal detonation physics. The conference was held by EMRTC, and included students involved in the current explosives engineering program at New Mexico Tech. The conference was useful not only because it identified students who may be interested in the HEET program, but also because it helped to establish relationships with professors at other universities and with scientists and engineers within the Department of Defense and other government agencies. Networking of this type has previously helped HEET to identify mentors and contractors for students.

As mentioned previously, four new students have become a part of the HEET program. They are expected to remain in the program for at least two years. Three of these students are currently involved in projects in ESA Division, and the fourth is in DX Division. All students are also currently taking classes in explosives engineering.

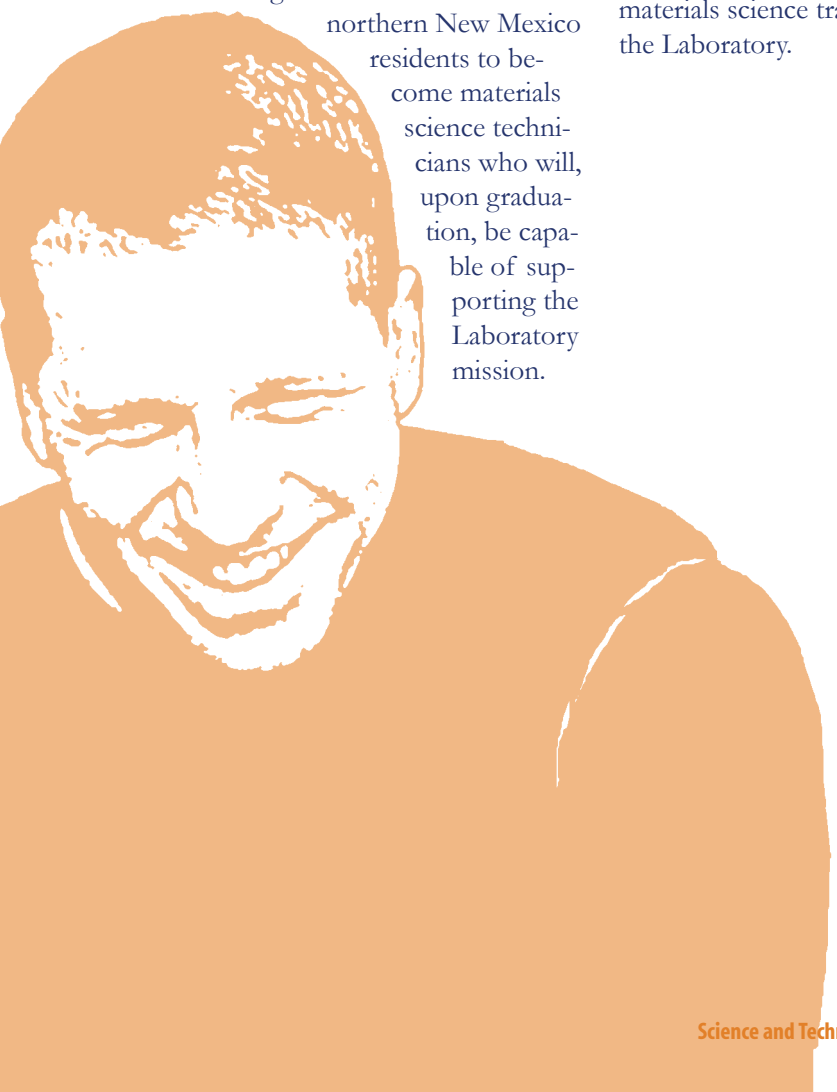
Finally, other universities—including the Colorado School of Mines and Virginia Polytechnic Institute and State University—have recently expressed interest in HEET.

## Materials Science Technician Training Program

***Project Description.*** Los Alamos National Laboratory (the Laboratory) is facing a serious problem: the aging of the materials science technician workforce. At present, 33.5% of these technicians are 50 or older—a figure that is similar to the 32% of all technicians at the Laboratory who are 50 or older.

Because of the shortage of technicians, a common practice is to hire recently retired Laboratory technicians as contract employees to perform the same jobs in the same groups from which they retired. This practice actually exacerbates the aging-workforce dilemma. The Materials Science Technician Training Program (the MST training program) is intended, instead, to provide a long-term solution.

The MST training program's formal goal is to recruit and train northern New Mexico residents to become materials science technicians who will, upon graduation, be capable of supporting the Laboratory mission.



Materials science has been identified by the Department of Energy as a critical-skill area vital to the future of its laboratories. The training program addresses this critical need. In addition, by recruiting locally, the program benefits not only the Laboratory, but also all of northern New Mexico. Researchers benefit because the technician interns are productive in a short time, are learning the fundamentals of materials science, and are working full-time, all year long.

Unfortunately, very few two-year, degree-granting programs in materials science (fewer than five) currently exist in the United States (U.S.)—and most of them are some distance from Los Alamos. The MST training program is addressing the serious deficit of new technicians by recruiting and training technically talented local people who would otherwise have to leave the state to receive the unique, specialized, materials science training offered at the Laboratory.

The training program in fiscal year 2003 (FY03) was a continuation of the very successful pilot program begun in FY01. The program is open to U.S. citizens with a high school or general equivalency diploma. The program consists of an internship (full-time, two-year, limited-term hire) at the Laboratory in an area that employs materials science technicians—for example, the Materials Science and Technology (MST) Division, the Engineering Sciences and Applications Division, and the Nuclear Materials and Technology Division. Each technician intern in the program works closely with a researcher/mentor and his/her team in a laboratory setting.

**Chastity Vigil, a participant in the MST training program, works on superconducting technology.**

These interns are given release time from their technician duties to attend classes at the University of New Mexico-Los Alamos (UNM-LA). When they complete the relevant UNM-LA program (42 to 44 credits), they are granted a certificate in materials science technology. An associate of arts degree in pre-engineering with a concentration in materials science (79 credits) is also available at UNM-LA. Introduction to Materials Science I and II courses, developed for the internship program, may be eligible for transfer credit at New Mexico Institute of Mining and Technology (New Mexico Tech), the only New Mexico university offering a bachelor of science or master of science degree in metallurgical and materials engineering.

The training program is supported by Laboratory management at the division level and by scientists who are intimately aware of the current need and the imminent shortage of trained, skilled, educated materials science technicians. The interns can be an extremely valuable resource, especially if they are teamed with a mentor who is highly experienced and soon to retire. In addition, it is less costly to recruit, train, and retain regional program participants than to import trained or untrained employees from outside the area. As a result, the training program is financially attractive to the participating divisions.

***Performance.*** The following items serve as measurable indicators of success:

- Number of students admitted and successfully completing the training program and associated course work each year;
- Number of students who graduate from UNM-LA with a certificate or associate degree in materials science technology each June; and
- Number of participants converted to regular, full-time technicians at the Laboratory.

***Highlights of This Year's Accomplishments.*** There were several significant accomplishments in the program in FY03.

Highly qualified technical staff members from within MST Division volunteered to teach materials science courses. Their contributions provided students with great opportunities to benefit from practical examples and added an increased level of credibility to the program.

An informal advisory committee and a student selection committee were formed to review the materials science program curriculum and to screen applicants. The committees were comprised of materials science technicians, managers, and technical staff members in MST Division. In FY04, the committees will be formalized to ensure ongoing evaluation of the program, formalization of procedures and responsibilities, and improved communication with UNM.

UNM-LA has received accreditation for the certificate degree in materials science technology and the associate degrees in pre-engineering with a concentration in materials science; and the New Mexico Tech Department of Metallurgical and Materials Engineering has approved two materials science courses in the certificate curriculum for transfer credit.

If all goes as planned, in December 2003, four program graduates will be eligible for full-time Laboratory employment.

Program improvements planned for FY04 include: the establishment of formal partnerships with New Mexico Tech, with Albuquerque (New Mexico) Technical Vocational Institute, and with other community colleges to disseminate two materials science courses via distance learning; and the enhancement and expansion of the laboratory component of the introductory materials science courses.

## Robotics Competition and Internship Program

*"We have found the robot workshops to be an excellent avenue for preparing nontraditional learners for technical careers. The students learn basic skills such as soldering and technologies like solar power. They (and their parents) also learn that a technical career is a real possibility. Perhaps the most exciting thing we've learned is that senior LANL technicians and staff members can not only help mentor the students but that they can act as role models, transfer their nonacademic and academic expertise to a hungry audience, and have fun doing it!"*
*Kurt Moore, Robotics Mentor*
*Los Alamos National Laboratory*

***Program Description.*** The Robotics Competition and Internship Program (Robotics) at Los Alamos National Laboratory (LANL, the Laboratory) is designed to involve the young people of northern New Mexico and surrounding states in a technology that they can understand—one that will excite them and turn them on to mathematics and science.

The Robotics competition was developed because of data showing the need for significant improvement in the education of students in northern New Mexico. Education is essential to maintaining an advantage in global competition, economic productivity, advancement in research and development, and technology application and commercialization. Without a solid education, a segment of the rural population will be left behind, and the social cost will be high.

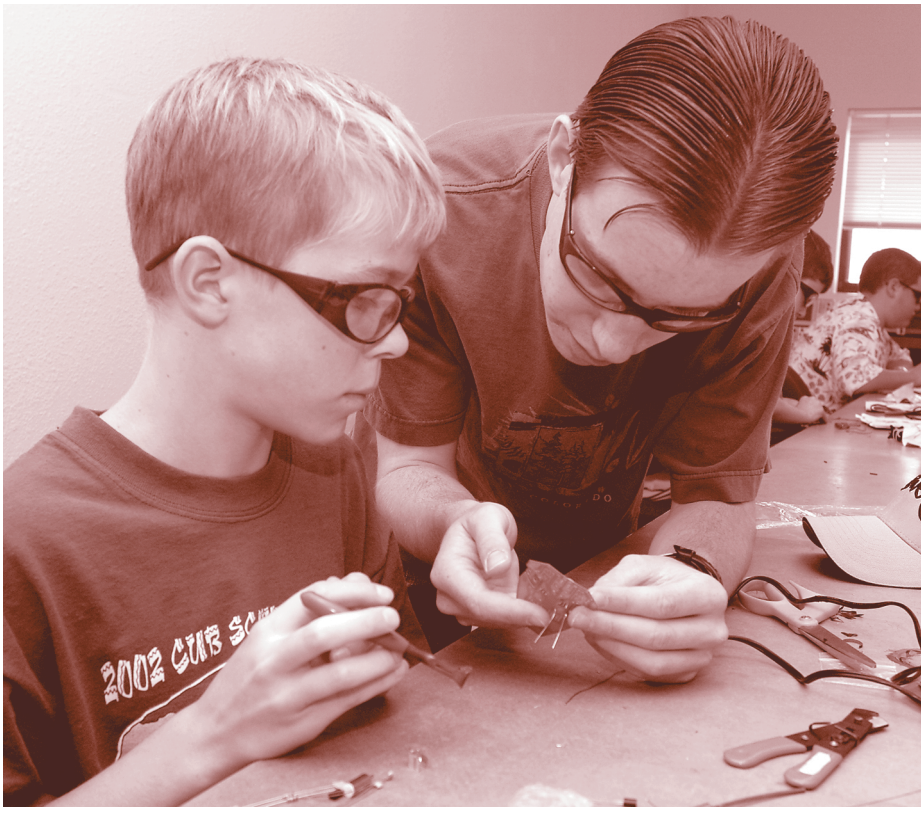
The United States (U.S.) weapons laboratories need a strong pool of U.S. citizens majoring in math and science in order to develop a future workforce. Robotics provides hands-on, minds-on experiences, creates excitement, and stimulates interest in science and technology by exposing students to the basics of robotic technology with the ultimate goal of recruiting these students into on-site student internships that will lead to future careers at the Laboratory.

Robotics is a great integrator in education. When students design and build robots, they study math, science, technology, and communications. Building a robot is a great educational exercise for a student because it provides applied experience in physics, mechanics, hardware, software, and logic. Robotics students also have to learn how to overcome failure and how to plan and organize a long-term, multifaceted project—necessary skills for many positions in weapons engineering and manufacturing. Robotics is a stepping-stone leading students toward becoming the next generation of scientists and technicians; it immerses them in activities using today's technologies.

The Robotics program is structured as a four-day, graded-level series of workshops and competitions with the more advanced students (grades 6 through 12) attending two separate two-day sessions, and the beginning students (ages 6 through 12) attending a basic one-day workshop. By having two separate sessions of the basic workshop, the program is able to accommodate the increased abilities of students who show an extended, multiyear interest in robotics technology. The third and fourth days allow these advanced students to create their own designs (without kits) under the supervision of the robotics instructors.

While it is called a "competition," the emphasis in the Laboratory's Robotics program is really on innovation and creativity.

The four-day Robotics Competition culminates each year in local competitions in which each student compares his/her work to the work of classmates. This friendly competition provides the incentive to create designs that make robots more efficient and more capable—major goals in robotics philosophy.



**Joshua Baer, right, a student from Los Alamos, New Mexico, who subsequently enrolled in the University of Dallas, helps with the Laboratory's Robotics Program, assisting a young scientist.**

The recruitment strategy for Robotics includes site visits and demonstrations at schools in northern New Mexico, news releases issued by the Laboratory Public Affairs Office, stories placed with local newspapers, radio spots broadcast in the Four Corners area, word-of-mouth promotion, math class visits and demonstrations, and information run on the Robotics website.

***Performance.*** The goals of Robotics are as follows: to identify students in middle school through the undergraduate years of college who have talent in the areas of science, math, and technology; to recruit them into Robotics and the Laboratory employment pipeline; and to expose them to science and technology and thus create more diverse and accomplished potential employees for the Laboratory's hiring pool.

All milestones were met in fiscal year 2003 (FY03).

***Highlights of This Year's Accomplishments.*** The following notable developments occurred in FY03:

- Four interns were placed in strategic research areas at the Laboratory. Critical skills that they had acquired in the Robotics program were instrumental in securing their internships.
- The Office of Nonproliferation Research and Engineering joined the internship effort as a sponsor.
- The FY03 Robotics Workshop drew more than 150 students from all over the U.S. Because the workshop was held in Los Alamos, more Laboratory staff members were able to participate than had participated in earlier workshops held in Santa Fe.
- Laboratory senior management continued to support working with the Navajo Nation and Jemez Pueblo on robotics workshops in the field and in rural, high-minority districts.
- The National Aeronautics and Space Administration (NASA) outreach program administered by the Laboratory Center for Space Science and Exploration agreed to merge with the Robotics program. FY03 was the third year of the NASA program, which had expanded to include grades 3 through 6 at Jemez Valley Elementary School. The combined programs now have equipment to accommodate classes of more than 30.

***Comments from Robotics Workshop Participants.*** One way to evaluate a program's success is through the eyes of students. Following are a few comments from those who participated in the Robotics Workshop:

*"The Robotics Internship program gave me the experience of working at a world-class Laboratory next to a mentor who is an expert in his field."*

*"The robotics workshop gave me the skills and confidence to work on instruments that are not working around the Laboratory. I fixed a high-speed photography motor, which allowed the Lab to use this expensive equipment for future experiments."*

*"I liked working side-by-side with the senior citizens of this community. Many of them are retired from the Lab and really know a lot about electronics and math."*

*"English is my second language, but I am good at working with my hands, so I was able to do well in the robotics competition. This experience makes me want to work on my English and math skills so that I can one day go to college"*

*"There were a lot of scientists from the Lab who came out to help us out here at the Jemez Pueblo! I thought they would never come, but they did, and it was fun!"*

*"The student mentors are very helpful and don't just build for us but teach us how to build and solve problems for ourselves."*

*"I want to be in the workshop again next spring, and when I am out of high school, I want to be part of the internship program so I can work in a Lab with smart people."*

*"The safety talk and the first morning of the competition were good. The Lab cares about our safety, and we had to wear safety glasses all the time. The building was the best part! I hope Joe Vigil can come to my school next year and show us his demonstrations on how the Lab uses robotics."*

**FY03 Robotics Interns**

| School Attended | Research Area | Gender/Ethnicity |
|---|---|---|
| University of Dallas | Isotope and Nuclear Chemistry | Male/Anglo |
| Colorado State University | Space and Atmospheric Science | Female/Anglo |
| New Mexico Institute of Mining and Technology | Space Engineering/High Speed Photography | Male/Anglo |
| University of New Mexico | Distributed Sensor Networks with Collective Computation | Male/Anglo |

## Summer School in the Physical Sciences for Undergraduates

***Program Description.*** Many of the best students going into scientific research today are not selecting the physical sciences. Instead, they are choosing biology and computer science.

This problem has caused concern for international physical societies as well as Los Alamos National Laboratory (LANL, the Laboratory) because the physical sciences form the core research areas of the nation's nuclear weapons stewardship.

To meet the continuing need for top scientists, the Laboratory needs stimulating programs to attract and retain the highest-quality students. Doctoral-level professionals are needed most. Early contact with them remains essential, and the Laboratory must instigate long-term, integrated efforts targeted at each stage of a student's progress through the formal educational process. National studies indicate that the best time to influence the choice of career comes during the last few years of undergraduate school because during that time period, students have gained the technical skills and background to appreciate scientific problems but have not yet specialized in particular areas or fields.

The Summer School in the Physical Sciences (SSPS) was designed to be the first stage in a critical-skills development program, identifying, attracting, and training top-flight students from around the country in the physical sciences that are of such importance to nuclear weapons.

SSPS, a joint program of the University of New Mexico (UNM) and the Laboratory, completed its 14th year in fiscal year 2003 (FY03). The program recruits nationally, targeting upper-level undergraduate students who will soon be making career choices, and focusing on a diverse pool of applicants.

Program participants are given intense and broad exposure to basic research in diverse areas of physics through lectures by distinguished scientists and through mentored term projects. The lectures and projects include such disciplines as astrophysics, weapons, condensed-matter physics, plasma physics, biophysics, laser physics, atomic physics, molecular physics, and optical physics.

In addition, SSPS has several broader goals: teaching certain basic physics skills not commonly emphasized in the university curriculum; introducing high-performance supercomputing; and fostering a personal interaction between research scientists and students. Program leaders believe that knowledge of the workings of scientific research, of frontier discoveries, and of the newest computer techniques will aid students greatly, no matter what career they ultimately choose.

For the past 11 years, SSPS has been funded by a National Science Foundation Research Experience for Undergraduates site grant to UNM; by the Critical-Skills Development Program at the Laboratory (through Department of Energy [DOE] Defense Programs [DP] funding); by in-kind support from the Laboratory's Theoretical Division; by the UNM Center for Graduate Studies; and by the UNM Department of Physics and Astronomy. In FY02, for the second year in a row, SSPS received generous support from line management in the Nuclear Weapons program at the Laboratory through the Advanced Strategic Computing Initiative.

**Two mentors and two students take a break from their work in the Biological and Quantum Physics Group (P-21) to talk about their experiences with the FY03 Summer School in the Physical Sciences. Left to right: Dana Berkeland and Garrett Kenyon, mentors, and Heather Partner and Gregory Ogin, students.**

In FY03, the 10-week SSPS was divided into two complementary activities—lectures, and a mentored student research project. SSPS leaders have found that this dual approach—lectures and research—best stimulates the students toward an active interest in science and avoids the pitfalls of a program devoted exclusively to one means of instruction. The lectures look outward, showing the vast, exciting nature of current global scientific research, while the mentored projects look inward, developing participants' skills in analysis and problem solving.

The lectures in FY03 focused on current "hot topics" in the field of physics, drawn from the speakers' own research projects. The lecturers introduced basic physical concepts from the perspective of ongoing research efforts. This mode of presentation gave the students an opportunity to participate in new investigations.

In an approach designed to complement the lectures, each student worked on a summer research project under the guidance of a mentor from the senior scientific staff of the Laboratory or UNM. A variety of projects were available, many of them concentrating heavily on high-performance supercomputing. The mentors carefully crafted each research project to fit the background of the student in order to guarantee the greatest and most effective participation.

The students participating received three hours of course credit from UNM for Physics 501. This credit has always been readily transferred to home institutions and, in many cases, has substituted for a senior research project.

The lectures were held in the mornings. Afternoons were reserved for research in an attempt to strike a balance between these two activities. Classes and computer sessions were held on the campus of UNM-Los Alamos. The UNM computer center has a fast link to the Laboratory network, provides powerful local capabilities, and is close to student housing. Its use encouraged a natural cohesiveness in the class. Class spirit was further fostered by tours of Laboratory facilities and local points of interest and by scheduled activities outside the classroom. The friendships made during SSPS form an important, enduring feature of the program noted by almost all students, past and present.

Programs such as SSPS that concentrate on undergraduate students provide a unique and powerful vehicle for captivating and recruiting highly talented students with tremendous career potential into areas of critical interest to the national security in general and to DOE in particular. SSPS fosters in students an extremely positive view of the Laboratory and its multifaceted research programs. The Laboratory must build on this enthusiasm with a coordinated series of interlocking programs that follow and attract students all along the lengthy path to a professional degree.

***Performance.*** SSPS met the main performance objective in FY03, encouraging undergraduate students to pursue research careers in the physical sciences—an objective that is vital to the DOE/DP mission. Meeting this objective has become more critical as computer firms and the biosciences continue to attract many of the best university students.

The short-term milestones of providing exciting projects and lectures to stimulate the students were amply met. (Please see the tables elsewhere in this section that detail students' research topics and the lectures provided by the program.) For the intermediate term, SSPS has repeatedly influenced students to continue research activities, to work on advanced degrees with joint Laboratory and university mentors, and to begin work in tenure-track university positions with continued strong ties to Laboratory personnel. Because undergraduates may take seven or eight years to complete a doctorate, we are just beginning to glimpse the long-term effects of this program.

***Highlights of This Year's Accomplishments.*** The year's highlights fall into four categories. Each is summarized below.

### Mentored Research Projects

In FY03, 17 students from universities in 14 states participated in the combined SSPS curriculum of lectures and individual research projects. The program drew broad participation from mentors representing four different Laboratory divisions and 12 Laboratory groups. Seventeen projects, supervised by 23 mentors, covered such diverse areas as magnetic superconductivity, plasma imaging, and neural simulator adaptation.

All students submitted detailed final reports—crafted along the lines of standard scientific papers—on their research accomplishments. The papers will be bound into a Laboratory publication for general distribution. In addition, an electronic version will appear on the SSPS website. To assist students in writing these reports, SSPS held a special class on technical writing, taught by Lee A. Collins, who serves as an associate editor to The Physical Review. The main emphasis of the school was the research experience. It gave students a first-hand taste of a technical project. The span of the program remains generally too short for the production of a finished, polished, and publishable piece of scientific research. However, several students plan to continue work on their projects, either independently or as a part of a senior research course at their respective institutions. SSPS leaders anticipate that these continuing efforts will produce publications in refereed research journals. One student and her mentor have already submitted an abstract for the next meeting of the American Astronomical Society.

This year, about a third of the students participated in Symposium 2003, a scientific meeting organized by the Laboratory that included student talks and posters. One of the SSPS students won the award for Best Physics Poster for "Dipole-Dipole Interactons in Magnetocarcinotherapy," and another won Best Technical Presentation in Materials Science for "Shear Viscosity under Shock-Loading Conditions."

Making use of contacts and projects initiated in SSPS, four past students returned to the Laboratory in the summer of FY03 to work with various research groups. Among those who returned were one member of the classes of 2000, two members of the class of 2001, and one member of the class of 2002. One of the returning students was a fellow of both the National Physical Science Consortium and the National Science Foundation. In addition, two recent Ph.D. recipients from the University of Nevada-Reno who are alumni of the SSPS classes of 1994 and 1995 have taken postdoctoral positions in the Atomic and Optical Theory Group (T-4) at the Laboratory.

### Lectures

In addition to participating in a mentored research project, the students attended a full set of lectures on an extensive range of topics as outlined in greater detail in a table elsewhere in this section.

These lectures serve as a perfect vehicle to highlight high-quality research programs at the Laboratory and at UNM, and they provide a marvelous recruiting opportunity. Distinguished lecturers were drawn from seven divisions and 21 groups at the Laboratory, from the University of Illinois (UI) at Urbana-Champaign, from UNM, and from Lawrence Berkeley National Laboratory in California. All lecture slots filled rapidly as soon as the program announced that they were available. This fact attests to the popularity of SSPS. The talks give staff members a rare opportunity to address talented students in an informal setting.

Professor S. Carney (UI), an alumnus from the SSPS class of 1995, served as visiting lecturer—presenting not only scientific lectures but also a session on career opportunities.

UNM was a strong participant again in FY03, and junior scientific staff members at the Laboratory—primarily postdoctoral fellows—were also enthusiastic participants. The opportunity to speak at SSPS often provides their only experience in preparing and giving lectures to a student group.

The lecture series was open to all other Laboratory educational projects, and SSPS routinely distributes the schedule to the Laboratory undergraduate and graduate programs. Students from other Laboratory programs attended many of the lectures.

### Activities

In addition to the formal lecture and mentor programs, SSPS arranged for a wide variety of related activities for the students. There were tours of various Laboratory facilities including the Los Alamos Neutron Scattering Center. The traditional SSPS "Night at the Santa Fe Opera" (SFO) continued. Students attended the opera "La Belle Helene." SSPS has, over the years, fostered a special relationship with SFO and has been able to acquire block tickets so that the whole class can attend a single performance. An opera night fits in well, given the program's strategy of recruitment from liberal arts colleges and the recent trend toward double majors in the sciences and the arts.

### Recruitment and Demographics

SSPS recruited nationwide for FY03, emphasizing students from schools with few or no graduate research programs. UNM handled recruitment, sending mailings to all members of several American Physical Society Divisions (approximately 2,000 fliers). In addition, a color poster was sent to most physics, chemistry, and astronomy departments in the United States. Special mailings went to minority-designated institutions. The SSPS website (http://www.phys.unm.edu/LASS) provides general information about the program and allowed for direct applications. In FY03, the program received more than 150 applications, the largest number so far, and admitted 17 students.

The FY03 class was very strong scholastically, attracting many honors students. The students came from 17 different universities ranging, geographically, from Massachusetts to California. The schools represented varied from liberal arts colleges with small research programs to large research-oriented universities. Participation by women increased to 47%. The program also drew five Asian participants.

**Universities and Research Topics of FY03 Students in SSPS**

| Student's University | Research Topic/Title of Final Paper |
|---|---|
| Cornell University | Magnetic superconductivity in ZrZn2 |
| Arizona State University | Nanosphere lithography on polymeric substrates |
| Wesleyan University | Free energy and phase stability in the Ag-Cu system |
| California State University-Long Beach | Conductivities in bilayer quantum hall systems |
| Mercer University | Remote-controlled filter changer for plasma imaging at NSTX |
| Salisbury State University | Six qubits entanglement of cold trapped ions |
| University of Maryland | BEC dynamic stability in an optical trap |
| Sweet Briar College | Helium accretion and detonation on white dwarfs |
| University of Rochester | Shear viscosity under shock-loading conditions |
| University of St. Thomas | Event-driven neural simulator adaptation |
| Indiana University | Use of an acousto-optic modulator to cancel frequency dither of iodine stabilized He-Ne laser |
| Carnegie Mellon University | B-dot probes in FRX-L |
| Winona State University | Dipole-dipole interactions in magnetocarcinotherapy |
| The College of New Jersey | Building a helicon plasma source for astrophysical simulations |
| University of California-Santa Cruz | An insight to the Epo-Jak-Stat signal transduction network |
| Harvard University | Simulation of impurity inclusions in FCC metal and the effect on dislocation movement |
| The Ohio State University | Nonlocal earthquakes |

**FY03 Lectures Presented in SSPS**

| Summer School in the Physical Sciences Lecture Series |
|---|
| Density Functional Theory |
| Extreme Solid Mechanics Simulations Using Particle Methods |
| Quantum Computing in Ion Traps |
| Near Field Optics/Scientific Career Planning |
| Techniques in Computational Physics |
| Data Acquisition in Physics |
| Fate and Transport of Pollutants: Case Studies from the United States, China, and Europe |
| Bioinformatics/Computational Biology: Systems Biology/Network Genomics |
| Tumor Biology and In-Vitro Experimental Models of Tumors |
| Realities of a Thermoacoustic Experiment |
| Quantum Key Distribution |
| What is a Plasma? |
| Magnetized Target Fusion: A High-Risk, High-Payoff Approach to Fusion Energy |
| Theoretical Modeling of Tumor Growth and Progression: Soft Matter |
| Neat Stuff in Quantum Mechanics |
| What Does the Second Law of Thermodynamics Look Like Under a Microscope? |
| Vulnerability Assessments of Security Devices, Systems, and Programs |
| Ocean Modeling and Climate Change |
| Electromagnetic Detection of Underground Structures: Musical Acoustics |
| Simulating Biological Neural Systems |
| Artificial Cavitation, Wing-In-Ground, Thermoacoustics |
| Producing High-Frame-Rate Movies with Charged-Particle Radiography |
| Carbon Nanotechnology |
| Cold Atom Physics |
| Quantum Electronics |
| High-Energy Nuclear Physics and Quantum Chromodynamics |
| Simulated Sand: Tumbling, Shaking, and Rolling |
| Computational Approaches to Fundamental Problems in Atomic Collisions: The Three-Body Coulomb Problem |
| High-Energy Physics |
| Nonequilibrium |
| Classical and Quantum Chaos |
| Cold Atom Physics |
| PHOENIX Heavy Ion Experiment/Trends in High Performance Computing |
| Quantum Information |